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Resilience and Sustainability:

Analyzing Urban Resilience and Sustainability Planning along the Upper Texas Gulf Coast

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Dedication

To my family,

thank you for everything.

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Abstract

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The University of Texas at Austin, 2019

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In this report, I analyze sustainability and resilience as part of the planning process by looking at efforts toward planning for local adaptability to changes in the natural environment and housing sustainability for the City of Galveston, Texas. In particular, I focus on the implications for low- and middle-income communities. To develop recommendations, I conducted case study research on the approaches to resilience planning taken by the Netherlands and by the City of New Orleans, Louisiana. The case of the Netherlands was used because it is often presented as an exemplar of planning for environmental resilience, particularly in the face of flooding. The case of New Orleans was selected due to its experience responding to challenges similar to those confronting Galveston: in the wake of Hurricane Katrina, New Orleans struggled to remain accessible to long-time residents, many with low to moderate incomes, while also becoming more resilient to environmental threats. Lessons from these cases were used to develop recommendations for the City of Galveston. Primary recommendations include placing greater emphasis on retaining housing for low and moderate income residents, on ensuring ongoing access to jobs for these residents, and for adapting housing to coastal environmental conditions.

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Introduction

As the world's societies continue the transition from largely rural and agrarian to predominantly urban, urban centers are now under pressure to develop in ways that accommodate the changes in lifestyle preferences by constructing new and affordable housing for those of varied demographics, implementing improvements in accessibility and connectivity, and responsibly designing sustainable cities that accommodate population growth while not implementing proper mitigation strategies for environmental hazards. Proper hazard mitigation introduces another concept that encompasses multiple facets of needed improvements in city building—resilience. In developing a framework for resilience, it is important to note that while literature has traditionally presented resilience as coming from an environmental lens, there are many components of resilience—including resilience in good-quality and affordable housing, environmental protection, hazard mitigation, economic sustainability, and human health and quality of life.

In recent years, the concept of urban resilience has evolved from focusing solely on environmental systems and their ability to adapt to adverse conditions, and has expanded—especially in the field of Urban Planning—to illustrate the complex nature of urban systems and how various factors are at play in influencing their abilities to function and thrive well into the future (Swanstrom, 2018). As the framework surrounding the concept of resilience has increasingly become attached to cities and regions, it now takes account of sudden, acute shocks including natural and man-made disasters, as well as long-term stresses on municipal and regional systems, including population declines, economic vitality, and overall housing affordability (Pendall et. al, 2009).

Resilience and sustainability have become issues of major concern on a citywide scale, as well as on a regional scale. Much of this is intrinsically linked to the overall health of the Galveston Bay Watershed. The exploratory effort of this report will examine the strides taken by city and regional officials to address resilience and sustainability in several key areas, while simultaneously making recommendations for how the city would make much-needed improvements. From a housing affordability perspective, this report will focus on the status of public housing in the city and programs geared toward preserving housing for low-income individuals, in addition to analyzing the average incomes of Galveston residents before and after Hurricane Ike in 2008, which was a major shock event for the island.

Focusing loosely on economic vitality, this report will explore the efforts of the Galveston policymakers to not only attract business to the city, but also existing efforts—if any—that the city is making toward ensuring that residents have access to jobs and economic stability. Centering uniquely on environmental sustainability strategies, I will explore the ways in which the City of Galveston has adapted its existing housing stock to changes that are occurring along the coast. In the analysis, all of the aforementioned will be compared to the principal reference city, New Orleans, and recommendations will be made largely based on what appears to be feasible for the City of Galveston.

After carefully examining the existing state of the environmental and infrastructure resilience in Galveston and the surrounding region, I will provide examples of existing ways in which the City of Galveston has attempted to address resilience through the lenses of housing affordability. What is the existing history of supporting affordable housing in the City of Galveston? Similarly, to what extent have affordable housing and housing for low- and middle-income families been altered by recent shock events—most notably Hurricane Ike in 2008?

Likewise, how has the City of Galveston actively sought to support the presence of affordable housing following recent shocks?

Acknowledging economic sustainability of the city as part of a larger, booming region, I will provide information on the current economic state of the City of Galveston. While the city was a major economic engine at the turn of the 20th century, the Galveston Hurricane of 1900 knocked it off its perch as the region's leading municipality. In the decades that followed, nearby Houston, which is located approximately 50 miles north of the island city along Galveston Bay, grew to achieve the leading status in the region as a port city with the construction of the Houston Ship Channel that connects to the Gulf of Mexico through Galveston Bay. Thus, Galveston, in some ways a caricature of its former self, was considered by many to have transitioned to a tourist economy. What is the history of economic development in the city as it pertains to land uses and proposed land uses for property parcels in the city? Furthermore, what measures has the City taken to attract sustainable businesses and ensure that working residents have access to long-term sustainable jobs?

Discussions about sustainability and resilience are incomplete without a unique focus on environmental resilience and sustainability. How does the City of Galveston Comprehensive Plan address challenges related to the city's geographic location? Likewise, what are the goals for the City in implementing resilience given its location along the coast? While Galveston is its own independent city, its position in relation to the Galveston Bay Watershed links it to the rest of the Houston-The Woodlands-Sugar Land Metropolitan Statistical Area. In what ways is sustainability on the island tied to existing or proposed efforts throughout the wider metropolitan statistical area?

Methods used to answer these questions involve examining housing and environmental data, as well as planning proposals set forth by city officials, to identify resilience and sustainability strategies employed locally and in my main reference city of New Orleans. Subsequently, I sought to build literature that speaks to urban resilience and sustainability, and its importance through case study comparisons. As mentioned previously, such literature analysis revolves around what has already been done, the successes and failures of what has been done, and how previously employed strategies could be implemented on a local level. Finally, on a minute scale, I have utilized graphics to illustrate data that portrays an accurate picture of the community's demographic makeup and built environment. Included in this is data pertaining to race and ethnicity and policy relating to housing affordability and the provision of affordable housing. Likewise, a substantial portion of my research methodologies document policy obstacles and opportunities toward incorporating resilience measures that operate at the level of localities.

In Chapter 1, I provide a literature review of sources that expounds on the meaning of the concepts of resilience and sustainability. Given what is established by the literature, it is apparent that despite the fact that resilience and sustainability are interrelated with one another, the differences that exist between the two concepts are what make them both necessary and important for integration into planning practice. According to the United Nations Habitat for a Better Future, resilience is the measurable ability of any urban system and its inhabitants to maintain continuity throughout shocks and stresses, while positively adapting and transitioning toward sustainability (UN Habitat 2018). As a result, any attempt to measure resilience requires a thorough assessment of the municipality's ability to plan and act when faced with hazards of all types. By the same token, sustainability is most generally defined as "the quality of not being

harmful to the environment or depleting natural resources, and thereby supporting long-term ecological balance" (Random House Publishing, Inc., 2019). Urban Planning expands upon such definitions of sustainability, integrating the concept with resilience in a way that assumes that planning that is truly resilient is also sustainable.

In Chapter 2, I explain my research design, outlining the methods that I used to conduct my research and explaining why I selected such methods. Additionally, I utilize this section to explain in depth why I elected to study the Netherlands and New Orleans to make recommendations for Galveston, Texas. Much of this lies in the shared similarities between New Orleans and the Netherlands in their efforts to make strides toward effective resilience and sustainability planning. In this chapter, I expand upon why Galveston, Texas was selected as an ideal city for a case study given its location, history, and current efforts to incorporate resilience and sustainability into planning from the perspectives of housing affordability, environmental awareness, and to some extent, economic vitality.

In Chapter 3, I provide a synopsis of my research findings, specifically outlining resilience strategies employed in the Netherlands and New Orleans, Louisiana. Delving deep into strategies employed in New Orleans, I examine the many steps that have been taken in New Orleans and throughout South Louisiana toward wetland restoration. This chapter makes it visibly evident that the strategies employed by policymakers in Greater New Orleans closely mirror what was done in the Netherlands, while simultaneously incorporating active discussion and research on resilience into all aspects of city and regional planning. Also analyzed is the area of housing resilience to determine how strategies have been employed on a local level can be implemented in Galveston.

Chapter 4 explores the regional environmental sustainability of the Upper Texas Coast, analyzing the existing conditions of the Galveston Bay Watershed and its importance for the many coastal cities that comprise it. This section includes an in-depth discussion on the importance of wetlands to coastal environmental health, and how changes induced by real estate development and mechanization over the course of the last century have grown to pose as great a threat to their sustenance as climate change. Finally, this chapter concludes by analyzing the ways in which steps have been taken toward implementing resilience and sustainability in planning along the Upper Texas Coast.

In Chapter 5, I thoroughly analyze the City of Galveston's Comprehensive Plan, taking into account effective measures employed in New Orleans and using them as points of comparison. This chapter includes five sections, including an Environmental Sustainability Analysis, an Economic Sustainability Analysis, and a section detailing sustainability in housing on the island. Finally, in Chapter 6, I conclude my research findings, summarizing the information gathered from the initiatives set forth in New Orleans and the Netherlands, as compared to Galveston, and what steps Galveston can make—if any—toward improvement.

Literature Review

Resilience and Sustainability: Two Interrelated Concepts

Resilience and sustainability are two important and interrelated concepts that will be the main focus of this report. While science officials and policy makers often use the terms interchangeably, it must be understood that they are distinct—despite their interconnectivity. As officials move toward improving planning efforts in urban centers on a global scale, having an improved understanding of the concepts of resilience and sustainability is of the utmost importance. Despite their interrelatedness, both concepts feature delicate intricacies that must be established in order to determine how they can best be implemented.

Resilience. In the urban context, resilience is conventionally defined as the "measurable ability of any urban system and its inhabitants to maintain continuity throughout shocks and stresses, while positively adapting and transitioning toward sustainability" (UN Habitat 2018). Thus, measuring a city's resilience requires a thorough assessment of the city's ability to assess, plan, and act when faced with both man-made and natural hazards. Traditionally, academic discussions on resilience have centered on climate change, natural disasters, and terrorism; however, what is excluded are measures of a city's economic resilience.

Traditionally, the National Ocean and Atmospheric Administration (NOAA) defines coastal resilience as the process of "build[ing] the ability of a community to bounce back after hazardous events, such as hurricanes, coastal storms, and flooding —rather than simply reacting to impacts" (National Ocean Service, 2018). Much of what is problematic about this definition is that it reflects the lack of understanding of resilience in the United States and how to best incorporate resilience-based frameworks into urban planning for coastal communities. NOAA's definition is almost completely defined by the ability of a community to bounce back from a hazardous event without making mention about the community's ability to sufficiently plan and

develop with hazards in mind, incorporating the natural landscape and its ability to provide *natural* mitigation tools for these communities.

Until recently, scientists had made few attempts to thoroughly understand the damage that anthropogenic changes have made to natural landscapes, which has been a key factor in making many coastal communities increasingly vulnerable to climate change and other forms of coastal intrusion. Thus, a better understanding of resilience for coastal communities is needed in both science and policy circles. More importantly, the scientific and policy communities need to adopt an understanding of natural habitats and their relation to coastal communities, which in turn allows for the incorporation of resilience strategies that build with natural hazards in mind, incorporating adaptive and creative strategies to enhance the ability of the natural environment to mitigate destructive events, such as hurricanes.

It is important to note that NOAA's definition illustrates a disjuncture between the scientific and policy communities surrounding the true nature of resilience in an urban context. The ability of communities to incorporate resilience into all aspects of planning and development is pertinent to a community's survival. As argued in the introduction, resilient comprehensive planning hazard mitigation and communities' abilities to effectively recover following shock events both involve a thorough analysis on ways to make community development sustainable. Such sustainability can be viewed in areas, such as housing availability and accessibility, proper building design, municipal and regional economic vitality, and active participation from a variety of stakeholders. As such, comprehensive planning that is resilient should not only focus on hazard mitigation and how effectively communities can recover in the aftermath of hazardous events. Instead, it is key that effective comprehensive planning should incorporate the opportunity to make multiple aspects of the urban fabric resilient. Such opportunities include the

construction of adequate housing and building stock that is designed in ways to incorporate changes in both the natural and built environments. Additionally, access to quality housing for individuals and families of all economic brackets, economic diversification to enable communities to reduce vulnerability to shocks, and public political awareness of local development politics are also of importance.

Sustainability. Planning that is truly resilient is planning that is sustainable. From an economic perspective, sustainable development and planning should be largely based on moving away from patterns that are solely engrossed in profit-driven growth without planning holistically. Economist Timothy Bartik of the W.E. Upjohn Institute for Employment Research argues that there has never been enough concern for the environment in the areas of urban planning and development. Traditionally, regional economic development policies have been focused on increasing the wealth of metropolitan areas, emphasizing job growth and the regional export base, while more modern approaches to sustainable development planning have largely emphasized various forms of innovation as the principal goal (Bartik, 1990).

Although the concept of sustainability was relatively new at the turn of the 21st century, planners and policy-makers had already begun exploring various ways in which the idea could be incorporated into practice. Scholars that participated in the Brundtland Report of the United Nations World Commission on Environment and Development (1987) highlighted the importance of "intergenerational equity and bemoaned society's troublesome tendency to shift environmental costs to a discounted future," although these sentiments were not immediately put into practice (Daly & Cobb, 1989; Rees, 1990; Campbell, 2016). From this, there is an unexpected merger of ideals—putting to rest the seemingly never-ending tug-of-war between

economists and environmentalists in planning and public policy. Embodied in this supposed merger are deeper ideals surrounding aesthetics, efficiency, and ethics (Campbell, 2016).

Citing the extent to which the concept of sustainability can be incorporated into planning and development, academic Scott Campbell cites three existing conflicts that sustainable planning would effectively address: the *resource*, *development*, and *property* conflicts. Each of these conflicts unfolds between three planning goals which are centered on sustainability: *economic development*; *equity/social justice*; and *environmental protection*. Campbell notes that the property conflict embodies the tension between the goals of economic development and equity/social justice, manifesting itself through debates centering on the modern social welfare state and the question of the need for economic redistribution through fiscal growth, as well as growth through equity—including higher skill levels and a growing middle class.

Likewise, as history serves as a relevant indicator, the resource conflict is the embodiment of the struggle between the goals of economic development and environmental protection, in which Campbell asserts the importance of "economic development through resource management and conservation" as well as the need to "protect the environment through affluence, internalized externalities, and new technologies" (Campbell, 2016). Of the three aforementioned conflicts, the most unique is the development conflict, which represents the rift between equity/social justice and environmental protection. At the center of the Development Conflict is the debate around environmental justice, in which planners and policymakers must strive to sustainably "achieve equity through environmentalism while simultaneously protecting through social justice" (Campbell, 2016).

Embodied deeply within this premise of the third conflict are notions of environmental racism, as well as equity in terms of access to affordable housing, quality living spaces, and the

resources distributed and available to communities that have historically been disadvantaged and are on the low end of the economic spectrum. Campbell acknowledges what is central to this research, which is that both creation and provision of equity are major components of sustainability—neither of which has been addressed in discourse or policy. In fact, as of 2016, there had been "[very few] … regulations or institutions [put into place] to enforce environmental justice" (Campbell, 2016). Such criticism posits that the concept of sustainability, especially as a component of resilience in urban planning and development, is a largely elusive ideal. This argument overlooks the infusion of the concept into various planning agendas over the course of the last several years.

Nevertheless, the concept of sustainability is—perhaps—an elusive one from the development perspective, in that sustainable planning can best be carried out today by "simultaneously using a useful organizing principle for community planning and a troublesome concept to be updated, challenged, and modified." According to Campbell, there have been recent improvements in the use of the term and its evolution over time. Likewise, the growing movement to achieve sustainable development planning will continue to be powerful as long as it devises spaces where planners and policymakers can make valuable progress. Thus, if the push for sustainable development were the basis for arguments on the elusiveness of sustainability, then this seems to make it all the more sustainable.

Existing Policy Framework and Development Patterns

Existing Policy Framework. While existing policy enacted by the United States Government through the Environmental Protection Agency strives to protect the integrity of wetland environments, it could be argued that the spatial and temporal reach of existing policy has been limited in some parts of the United States Gulf Coast from Texas to Florida. According

to the Environmental Protection Agency, Section 404 of the Federal Water Pollution Control Act, also known as the Clean Water Act, establishes programs for the management of discharge of dredged and fill materials into U.S. water, including wetlands. This section of the act establishes regulation activities like water resource projects, including the construction of dams and levees (Environmental Protection Agency, 2017).

In analyzing the impacts of permits issued under Section 404 of the Clean Water Act that required compensatory mitigation of freshwater wetlands and ecosystems in Texas and Arkansas, researchers found that there was ample loss of wetland area in the Dallas-Fort Worth area between 1982 and 1986, leading them to theorize that such losses were largely related to the real estate market in the area and associated growth patterns and expansion into woodland areas (J.C. Sifneos et. al, 1992; Samuel D. Brody et al., 2008). Similarly, a report on the spatial-temporal analysis of Section 404 wetland permitting in Texas and Florida between 1991 and 2003 cited several research studies that indicated the same trajectories in terms of development patterns, leading the authors to theorize that while Section 404 of the Clean Water Act regulates urban land use and development pertaining to wetland areas, the legislation performs poorly as such, even contributing to wetland losses (Samuel D. Brody et. al, 2008).

The Society of Wetland Scientists notes that while the State of Texas has not yet experienced the same amount of wetland loss on the immediate coastline and coastal prairies as the State of Florida, similar degrees of suburban development in Southeast Texas (notably surrounding Houston) and South Texas along the Upper Texas Coast (near Corpus Christi) have seen development patterns that mirror those of Florida. Outside of the Greater Houston and Corpus Christi Metropolitan Areas, the Texas Coast is relatively undeveloped which allows the natural hydrological structure of the watersheds to be more intact and cohesive than those in

Florida (Samuel D. Brody, 2008). Texas' share of the coastal population is relatively low; however, demographically, data reported in 1990 indicated that the U.S. coastal population was projected to double 1960 levels by 2010 (Cutillon et. al, 1990). Still, growth projections for the end of the decade from 2000 to 2010 indicated that the Texas Coast was projected to experience ample growth in the coming years, and as stated previously, population growth projections have increased over the last ten years. Therefore, it is almost inevitable that the Texas coast will experience accelerated wetland alteration and potential problems with watershed flooding (Brody et. al, 2008).

Study results from the Society of Wetland Scientists indicated that there was a heavy concentration of wetland alteration in urbanized areas, especially in the Houston/Galveston, Beaumont, and Corpus Christi areas. Wetland alteration and the distribution of permits in these areas is more dispersed than in Florida, which researchers believe is due to the lack of federally protected areas along the coast and the sprawled nature of urban development. The fact that nearly 80% of wetland permits in Texas were issued outside of urban areas attests to the impacts that urban expansion has on coastal wetland areas. Furthermore, from a standpoint of flood mitigation, the areas that are most vulnerable to flooding that included wetlands and that therefore could have served as valuable resources for flood mitigation, ended up accounting for nearly 40% of permits issued along the coast, especially in the Houston region. Most of these permits were issued in the 100-year floodplain (Brody et. al, 2008). Study results further illustrated that the most harm along the Texas coast was done to estuarine wetland ecosystem areas, with heavy concentrations of development in areas adjacent to Galveston Bay and Corpus Christi Bay. Likewise, ample development permits were issued along palustrine (non-tidal) wetland areas, such as bottomland hardwoods. The increases in issuances of such permits

coincided resulted largely from sprawl that was not along the immediate coastline or Galveston and Corpus Christi Bays. Nevertheless, such development did have impacts on bay-area estuarine systems (Brody et. al, 2008).

Effects of Ongoing Local Development Patterns. The effects of uncontrolled development patterns on natural mitigation systems can be seen throughout the country, but especially along the Upper Texas Coast. Regionally, both coastal marshes and bottomland hardwood forests—which serve a protective function have been faced with drastic threats that have led to their destruction. Many of these threats have largely been induced by development patterns implemented over the course of the 20th century. While this is a problem that has occurred along the Texas Gulf Coast, it is endemic to coastal areas throughout the United States. Research suggests that over the course of the last two centuries, more than half of all of the nation's wetland areas have been lost largely due to human activity. Based on recent climate change projections and related effects, these losses are only likely to increase. Furthermore, the Society of Wetland Scientists notes that despite the importance of wetland areas to communities and ecosystems along the coast, federal legislation has not done nearly enough to protect the integrity of these ecosystem environments. The lackadaisical nature of federal regulation has exacerbated increases in development that puts these areas further at risk.

Therefore, it comes as no surprise that while coastal areas experience changes as a result of a changing climate, human impacts have also done a great deal of damage to coastal wetland areas—and those along the Upper Texas Coast are no exception. Research by Matthew L. Kirwan of the Virginia Institute of Marine Science and Patrick Megonigal of the Smithsonian Institution identify the effects of sea-level rise on wetland areas and the abilities of these areas to protect themselves. By the same token, their research also provides an outlet to analyze the ways

in which human activity alters the nature of these wetland areas. Their research makes it evident that sediment availability, biotic responses to environmental changes, wetland migration inland, and environmental attitudes that influence land use patterns are of just as much importance as climate change (Kirwan & Megonigal, 2013).

Human impacts have involved the conversion of wetland areas for agricultural and aqua-cultural purposes. Kirwan and Megonigal's research suggests that these conversion methods have resulted in the loss of between 25% and 50% of the world's wetland areas over the course of history. Within the next century, projections estimate that between 20% and 25% of the world's remaining intact wetland areas will be lost for the same reasons (Huang et. al, 2010; Pendleton et. al., 2012). Kirwan and Megonigal demonstrate that most coastal wetland areas undergo a process of vertical accretion, through which they must build up their soil elevations at rates that are faster than or equal to that of sea-level rise. Through the process of vertical accretion, what generally occurs is the vertical build-up of (subsurface) soil material on top of the existing wetland surface (Kirwan & Megonigal, 2013; Lane et. al., 2006).

With this comes a set-up of plant feedback above ground and below ground, including plant shoots for slow-water velocity, as well as those that add organic matter to the soil surface. The authors' research also found a positive correlation between the growth of wetland-type grasses and inter-annual variations in sea-level (Kirwan & Megonigal, 2013). Vertical accretion also allows for faster rates of plant growth, which in turn proves to be beneficial for these areas—slowing down water velocities, reducing wave heights, reducing erosion rates, and enhancing the deposition rates of sediment that furthers the processes of vertical accretion. Kirwan and Megonigal note that there have been widespread conversions of marsh wetland areas to open water in the wetland areas near the Gulf of Mexico, the famed Venice Lagoon in Italy,

and the Chesapeake Bay Region. This loss of wetland area can be attributed to the fact that these areas are largely low-lying amidst faster rates of sea-level rise, while simultaneously being inundated by saltwater tides that destroy vegetation and plant productivity, in addition to reducing organic matter and acceleration of erosion, and further deteriorating wetland areas (Kirwan & Megonigal, 2013). What is visible in other wetlands where there have not been significant area losses are scale feedbacks in terms of the wetland area's spatial landscape. Often times as sea levels rise and wetlands are inundated with seawater that has the potential to destroy their ecosystem areas, wetlands begin migrating inland from the immediate coastal zones (that are characterized by estuarine wetlands) to the areas along the coastal plain.

Common in these areas is the expansion of channel networks for sediment delivery. For example, as has been evident in the Yangtze River Delta in China, rapid erosion of subtidal flats provides sediment to adjacent wetlands in the Delta, which allows these marshes to maintain their aerial extent. Likewise, the expansion of these channel networks in response to sea-level rise ends up transferring "more sediment to portions of the wetland platform that were previously sediment deficient", explaining how wetland areas have continued to persist in intertidal zones over thousands of years (Kirwan & Megonigal, 2013).

From this, one could infer that wetlands have developed natural responses to protect themselves from destruction over the course of thousands of years as a result of changes in sea level. Kirwan and Megonigal note that there is ample evidence to prove that sea-level rise remained relatively stable over the course of thousands of years and did not begin to rise until the end of the 19th century (Kirwan & Megonigal, 2013). Undoubtedly, it is not far-fetched to assert that this was an accompaniment to changes in the earth as a result of the then-ongoing industrialization. While measurements of tidal accretion rates in wetland areas do correlate to

models that project increased rates of sea-level rise, there is still no evidence of widespread wetland loss that could be attributable to climate change (Kirwan & Megonigal, 2013).

In analyzing human impacts, Kirwan & Megonigal note that eight of the world's largest coastal cities now experience threats that result from sea-level rise rates that greatly exceed climate projections. They note that between 40 to 50% of wetland loss can be attributed to human modification. For example, sources cite that 20% of global sediment is prevented from reaching the coast as a result of damming. Likewise, wetland areas along several coastlines have been lost due to conversions of these areas into arable lands for agricultural and aqua-cultural purposes. On the U.S. Gulf Coast, perhaps most notable over the course of the last century includes the construction of dikes, levees, and various flood protection systems that have contributed to what has been deemed the "shoreline squeeze" through which erosion removes the wetland area at the margin. Likewise, the construction of structures prevents the addition of more wetland area through vertical accretion and inland migration toward upland areas (Kirwan & Megonigal, 2013).

Economic Resilience

Maintaining a Sustainable Economy. Through the Economic Development Administration, the United States Department of Commerce has cited the importance that regional economic prosperity plays in "an area's ability to prevent, withstand, and [rapidly and sufficiently] recover from major disruptions to is economic base" (U.S. Department of Commerce, 2018). Still, as is the case with other areas of resilience, a region's inhabitants must come to understand how to implement economic resilience in ways other than planning how to merely recover from a disruption. Drawing upon the information provided by the U.S. Department of Commerce, an urban area must not only be able to quickly recover from an

economic shock, but it must also be able find ways to avoid experiencing the shock and sufficiently withstand the impacts of a shock in the event that the latter proves impossible (U.S Department of Commerce, 2018).

Economic shocks to an area can include external shocks, such as natural or human-induced disasters, as well as domestic or international economic downturns and industrial economic changes that have widespread effects on a region's economic vitality. In building economic resilience, it is important that cities implement what the Department of Commerce defines as *steady-state* and *responsive* initiatives. Steady-state economic development initiatives require that cities undergo comprehensive planning that involves ample residential participation, as well as that of other stakeholders. All stakeholders involved in such planning processes play a crucial role in efforts toward enacting a collective vision for economic resilience. Such transformations could be made through economic diversification and a collective broadening of industrial sectors, investment in the local workforce to make them more resilient to changes in the employment market, making adaptations to business retention and expansion programs to assist firms with economic recovery following shock events, and the adoption and incorporation of disaster-resilient strategies into local development policies and practices.

Similarly, responsive economic development strategies include conducting pre-disaster recovery planning to "identify key stakeholders, as well as their roles, responsibilities, and key actions" (U.S. Department of Commerce, 2018). Further entrenched in these strategies is the establishment of communication processes to keep all major stakeholders and players abreast of the local needs, in addition to implementing leadership mechanisms in the short-term and long-term future.

Varied Municipal Realities. Speaking to the importance of economic diversification alone, one need look no further than Detroit, Michigan and its increasing lack of economic resilience that was exhibited during the first half of the 20th century. Failure on the part of city officials to diversify the local economy outside of the automotive industry made the local population increasingly vulnerable to economic adversity following industry slowdowns. Unfortunately, this created a chain reaction that—coupled with other happenstances, such as the departure of white residents to booming suburbs that mostly excluded African Americans, sparked mass migration from the city and a resulting decrease in local tax bases. Over the course of the succeeding decades and into the present, those residents remaining in Detroit have not only been vulnerable to living in or falling into poverty, but they also are now subject to displacement in light of recent economic development trends and urban reinvestment. Innovative planning methods in the past that could have developed a sustainable framework for a resilient future could have explored ways to diversify the city's economic sector to ensure that locals not only remained part of the labor force, but were also able to connect with emerging and existing enterprises (Fukuda, 2014).

Detroit is only one example however; in fact, failure to sufficiently plan for an economically resilient city is quite common nationwide. For example, in the aftermath of Hurricane Katrina in 2005, the City of New Orleans has made it a top priority to foster economic sustainability in its Comprehensive Development Strategy, considering that the overall loss to the city's local economy was approximately 95,000 jobs within the first year following the storm. When analyzed in terms of wages, the hurricane caused a loss of nearly $3 billion in wages with much of this loss being evident in the private sector (Dolfman et. al, 2007). While the city has made great strides to diversify its economy since the storm, the most prominent

employment sectors are tourism, port operations, and educational services (Dolfman et. al, 2007). Before the storm, New Orleans was by some standards an economically distressed city, with the average weekly wage hovering below the national average. This was due in part to the fact that many of the jobs held by New Orleanians were in some of the lowest-paid employment sectors, including hospitality, food service, and retail trade (Dolfman et. al, 2007).

Sustainable Housing Initiatives

Housing Sustainability. Sustainability in local housing stock is closely linked to a region's economic vitality. For example, the City of New Orleans has witnessed rising housing costs and associated displacement that is gentrification-induced, in addition to structure demolitions that decrease the availability of housing units, ample evictions, and owner-conversions of rental units—all of which have exacerbated the displacement that was set in motion by Hurricane Katrina in 2005. Martin Sinel notes that post-Katrina changes in the availability of affordable housing in New Orleans was the result of neoliberal political ideologies that had been brewing for decades to dismantle government funded, non-market institutional structures (Sinel, 2016).

Furthermore, Sinel also notes that disasters on the similar scale as Katrina "tend to produce systemic rupture, creating space for new frameworks of governance to form or old systems to re-root, driving subsequent patterns of development, and producing the context for future disasters" (Sinel, 2016; Gotham and Greenberg, 2014). Given the devastation caused to the physical landscape by Hurricane Katrina—and truthfully speaking, any disaster of such a large scale—existing policies were left unguarded and ripe for revision in the period immediately following impact of the shock event. Sinel asserts that this lack of guardianship in the political landscape is what made it possible for the political processes, or lack thereof, to remove existing

low-income housing in the city (Sinel, 2016; Goetz, 2013; Johnson, 2011). As a result, four of the largest housing projects in the city were closed in the years following Hurricane Katrina, while several others were scheduled for demolition due to purported rehabilitation efforts being too costly despite the fact that these units did not sustain structural damage during the storm (Goetz, 2013).

The Case of Galveston. A similar debacle occurred along the Upper Texas Coast in Galveston, Texas. Hurricane Ike made landfall in September 2008, causing mass devastation throughout the region and crippling the city of Galveston. Sources indicate that in the storm's aftermath, the federal government invested billions of dollars in local governments as part of the recovery effort. As of April 2018, nearly $76 billion of those funds had not yet been deployed toward recovery efforts, and research reveals that all of those unused funds had been intended for the reconstruction and rehabilitation of affordable housing for the city's low-income residents after the storm (Walters, 2018). In the ten years following the hurricane, there has been an often-times intense battle over whether federally subsidized affordable housing units should be rebuilt to replace those units that were lost as a result of the hurricane. Undoubtedly, opinions were divided among class and racial lines, as the residents of many of Galveston's public housing projects were disproportionately poor and African American.

Much of the public housing in the city is operated by the Galveston Housing Authority, which began operations in 1940 to meet pressing needs for quality subsidized housing for city's working-poor. Before Hurricane Ike destroyed all of the city's public housing units, the Galveston Housing Authority operated 942 units in four family developments, two senior developments, and scattered sites—in addition to administering more than 1,200 Housing Choice Vouchers (Galveston Housing Authority, 2018). Today, the Galveston Housing Authority only

operates 450 units of public housing, but 1,500 Housing Choice Vouchers, which represents nearly a 50% decrease in the number of affordable housing units available in the city since the storm.

In fact, John Henneberger of the Texas Low-Income Housing Information Service notes that Galveston exemplified [after Hurricane Ike] the way[s] in which local opposition and delaying tactics could thwart civil rights laws aimed at stopping housing discrimination" (Walters, 2018). A March 2018 report released by the Federal Reserve Bank of Dallas indicated that the failure of Galveston city officials to provide access to affordable housing has resulted in a community that is also less economically diverse and more prone to facing workforce challenges in the near future, particularly considering its location with one of the fastest growing cities in the nation.

Research Design

Much of my research is based on an exploratory, comparative case study design. I have found it necessary to take this approach, as a key theme central to my research is exploring what steps other coastal cities have taken toward achieving sustainability and resilience in planning in order to make possible recommendations for the City of Galveston, Texas. The exploratory phase of my research will briefly examine strategies employed in New Orleans, Louisiana—many of which were modeled from those employed internationally in the Netherlands, which is a global leader in resilience and sustainability planning. In the years following Hurricane Katrina, public officials in New Orleans have made enormous strides toward incorporating resilience and sustainability frameworks into their planning models through public-private partnerships and aggressive educational campaigns geared to rally the support of the general public. Efforts in other coastal communities illustrate that sustainability and resilience can be incorporated into regional planning initiatives to foster wetland restoration and mitigate regional flood hazards moving forward, in addition to other areas of resilience planning through sustainable housing provision and fostering a resilient economy. Planning such strategies takes time, but the incorporated frameworks can be very much worthwhile for municipalities in following decades.

Narrowing the focus to Galveston, Texas, the city spans the entire barrier island of the same name and also includes nearby Pelican Island, which is located to the north of Galveston Island at the mouth of Galveston Bay. Situated approximately 30 miles southeast of Houston, the city's population was just under 50,000 people in 2017 according to the U.S. Census. Based on a data analysis of the city's population growth since 2007 just before Hurricane Ike, when the population was nearly 54,000, Galveston appears to have only seen slight population growth since the aftermath of Hurricane Ike (Sinel, 2016; U.S. Census Bureau, 2007). The city's Economic Development Office reports that the city's economy is largely based on maritime

shipping, education and healthcare, as well as tourism and hospitality; such data is congruous with the city's location directly on the coast of the Gulf of Mexico (City of Galveston Office of Economic Development, 2018).

Historically, Galveston was known as "the port and playground of the South" prior to the Great Hurricane of 1900. Nevertheless, in the years preceding this economic and environmental shock, it had served as the main port center for the Texas Navy, and briefly served as the capital city for the Republic of Texas in 1836 under then-Republic of Texas President David G. Burnet. Decades later, the city played a major role in Texas' role in the U.S. Civil War. Following the 1900 Hurricane that leveled much of the city, the city constructed a 16-foot seawall as an attempt to protect the city from large storm tides, which ushered in a new era for Galveston. Estimates today reveal that approximately 7 million people visit the island city on an annual basis, bringing in a total of $833 million in visitor spending (City of Galveston Office of Economic Development, 2018).

Following the devastation from Hurricane Ike in September 2008, existing vulnerabilities became evident in the supply of existing housing options available for people at various income levels (Sinel, 2016). Earlier research reveals that there was a high-profile struggle over the demolition and reconstruction of traditional public housing facilities in the hurricane's aftermath, a process that still remains ongoing after more than 10 years and yet another devastating hurricane to the region in 2017. Additionally, questions regarding the city's efforts to sustainably rebuild became prevalent when researchers began recommending that the city prohibit construction in low-lying areas that were vulnerable to flooding.

Research Findings—Case Studies

Case Studies: Resilience Strategies employed in the Netherlands

The Netherlands has become widely known—not only for having an abundance of wetlands—but also for its strategic management techniques that capitalize on the natural features of these ecosystems and the benefits that they have for the country's coastal regions at-large. In fact, 16% of the nation's territory is considered to be important wetland systems, while 7% of the nation's territory has actually been registered as such. The Dutch coastal wetlands consist of estuarine wetlands (coastal salt marshes and tidal flats) along the Rhine, Meuse, Scheldt, and Ems Rivers —the first two of which play major roles in the country's hydrology due to the amounts of water that they receive from Europe's Alps region and the water systems' composition of fast-flowing riverine reaches and tidal estuaries. As a result, the Netherlands incorporates many wetland areas into its floodplains (Best et. al, 1993).

The Netherlands consists of ample freshwater wetlands as well—which were almost exclusively created from reclamation that resulted from anthropogenic alterations to the natural landscape, whereby land was converted from wetland area for agricultural purposes through damming. By the late 20th century, many of the country's wetlands were faced with ample threats, and almost all of them were the result of human activities. For example, research conducted at this time revealed that the main threats resulted from the following:

- Changes in hydrology that led to increased discharges, decreases in fluctuation of water levels, drawdown, desiccation (resulting from excess withdrawal of groundwater) and subsequent mineralization of topsoil;
- Air pollution leading to acidification, eutrophication, and toxification of terrestrial and aquatic systems; and

- Direct eutrophication and toxification of surface waters.

It is increasingly evident that in the Netherlands—as is the case with many places—threats to wetlands are largely related to the connection between their structures and the surrounding landscape and forced (anthropogenic) alteration of the natural landscape (Best et. al, 1993). Late 20th century research indicated that climate change posed threats to the country's wetland areas, but also indicated that the effects of climate change on these systems was largely correlated with human-induced changes (Best et. al, 1993).

Historically, the fight against the sea has always been one in which the Netherlands has been a strong contender. For thousands of years, the estuaries of the major river systems in the Netherlands have been subject to major floods. Likewise, embankment and subsequent reclamation of the many marshes leading out to the North Sea both have been going on for centuries. By the dawn of the 20th century, technology began to aid the Netherlands in pumping and draining wetlands, especially those further inland, such as swamps and peat moors (which are upland habitats that are characterized by low-growing vegetation on acidic soils), resulting in ample loss of wetland area (Wolff, 1992). In 1953, a major storm struck the Dutch coastline, sending massive surges into the estuaries along the southwest coast of the country and causing widespread loss of life (at more than 2,500 casualties) and ample property damage. It was around this time that Dutch officials began to consider implementing an updated flood protection and water management project, which would come to be known as the Delta Programme.

In 1958, the government adopted the Delta Act, which aimed to close large estuaries and reinforce the Dutch coastline with large flood and storm surge barriers. While this was carried out, updates were made to the existing barriers in the late 1980s, proving to be what was then the most expensive engineering project undertaken in the Netherlands. At the same time, the

government was responsible for creating and reinforcing more dikes along the coastal marshes, in addition to raising their height by several feet to ensure that they would not be overtopped in the events of high storm tides. By the late 20th century, what became clear to officials was that the Delta Programme, as it then existed, would have to be updated, altered, and become more resilient (innovative) in order to maintain its efficiency.

Devastating floods witnessed in 1993 and 1995, consecutively, attested to then-existing inefficiencies with the Delta Programme. However, during the 1970s, conservationists in the Netherlands had already begun to decry the Delta Programme and its modernized mechanisms for wetland reclamation on the grounds that construction costs were skyrocketing and that the projects were causing harm to the local ecosystems, recreational areas, and coastal fisheries (Wolff, 1992). Ultimately, these observations coupled with changes in local politics led to the reduction in land reclamation. Realistically, consistent reclamation was also causing economic strains, considering that sea levels were continuously rising, causing the country to have to apply more expensive and efficient engineering techniques toward maintaining the existing flood protection systems.

Today in the Netherlands, the strategies being employed toward water management and coastal resilience involve the adoption of innovations in policy complemented with technological advancements. Contrary to previous strategies of recapturing land space and building ample barriers to keep water out, modern scientists and policymakers have come together relying upon research that attests to the benefits of making the country more resilient amidst a changing climate and rising sea levels. Thus, local politicians have begun devising plans to let water in wherever possible, allowing residents to adapt to living with water instead of constantly struggling to defeat it. They have done so in the most creative of ways. For example, the Dutch

now devise lakes, garages, parks, and community squares to not only serve benefits to enhance the quality of daily life, but also to serve as enormous reservoirs during extreme flooding events (Katz, 2013). These innovative strategies contrast with the earlier ones employed by the Delta Programme following the North Sea Flood of 1953, as subsequent legislation called for the closing off of river deltas from the North Sea. Today, the North Sea embraces a strategy that incorporates the philosophy of living with water—thereby integrating wetland conservation and improved resilience strategies into development plans, as opposed to diverting water from the North Sea to construct development.

Other efforts to improve water management in the Netherlands that capitalize on technological advancements to enhance the natural environment for the benefit of the nation's wetlands include the development and implementation of the Sand Engine. Resulting from a collaboration between various Dutch universities, public agencies, and private stakeholders looking to invest capital into programs to improve the resilience of the country's urban fabric, the Sand Engine is a large volume of dredged sand that was strategically added to the coastline; while it might appear high-tech, the concept is one that harnesses the natural system of ocean currents with engineering to replenish the country's eroding coastline. The mechanism consists of 21.5 million cubic meters of sand that was added by the consortium to create 10,000 acres of land for natural and recreational use. With the help of currents from the waters of the North Sea and wind, the added sand will be distributed along the beaches of the Netherlands, providing natural barriers from rising tides and helping to regenerate estuarine ecosystems and wetland areas that were destroyed as a result of anthropogenic changes over several decades. With time, the mechanism is projected to fully become incorporated into the natural landscape and provide the nation with long-term fortification for eroding beaches. This essentially saves the nation

money from having to replenish sand along the beaches in short-year intervals through the use of traditional dredging materials that have been known to cause environmental and structural damage to the coastline. Estimates purport that the Sand Engine will replenish the sand along the nation's beaches over the course of the next 20 years at half the cost of doing business without it (Kakissis, 2017).

Lastly, the Netherlands has devised an initiative known as "Room for the River," in response to the catastrophic losses caused by the 1993 and 1995 floods. This strategy embodies modern thinking throughout Dutch government and the scientific community that raising dikes and levees is not a sufficient solution to keep rising tides at bay. The plan incorporates the presence of the four major rivers in the country and combines flood protection with landscape improvements. The first of these strategies involves the relocation of dikes from rivers and shorelines to allow more space in the floodplain for rising/surging waters during extreme events. Additionally, the plan has called for the deepening of flood channels and the floodplain itself; by increasing the depth of the floodplain, officials have devised a method by which they can remedy the constant accumulation of sediments in the floodplain after regular flooding events.

Likewise, side channels through which water flows en route to the North Sea will be lowered to increase barriers between the rivers and housing and commercial infrastructure, in addition to decreasing the likelihood that breaches will occur in already existing flood barriers. As is part of the nature of the plan to make room for the river(s), the initiative also calls for the removal of obstacles that were put into place in earlier years to obstruct the flow of water from the sea (Kakissis, 2017).

Case Study: Resilience Strategies in Greater New Orleans

There have been several positive steps taken toward wetland restoration along the United States Gulf Coast, especially in Florida where wetland mitigation strategies mirror those undertaken along the Chesapeake Bay with the implementation of living shorelines to create natural wetland areas along bays and harbors where development eradicated previously existing ones. Ample work has been done in the state to restore the Everglades. By the same token, wetland mitigation and resilience strategies have been employed along the Mississippi and Alabama coasts in the years following Hurricane Katrina, in which local officials have sought to incorporate resilience initiatives into the comprehensive plans of coastal cities from Mobile, Alabama to Biloxi, Mississippi. Nevertheless, what is perhaps one of the most monumental moves being made at present along the Gulf Coast is the recent consortium of efforts being undertaken in southern Louisiana, especially in the City of New Orleans, Louisiana.

Greater New Orleans is situated in southeastern Louisiana where the Mississippi River empties into the Gulf of Mexico. Within the City of New Orleans alone, more than 1/3 of the land area is comprised of wetlands; the city's coastal location comprises its most prominent threat: water. Historically, New Orleans was able to adapt to living in close proximity to water. The oldest sections of the city were built on natural levees near the Mississippi River, which are high ground and resistant to flooding. However, with the dawn of the 20th century and improvements in technology, city officials and engineers were able to pump and drain swampland in lowly elevated portions of the city and region, as a means of incentivizing development into areas that had previously been uninhabitable. Likewise, with this development came urbanization and sprawl that created further complications for drainage and water management in the city (City of New Orleans, 2015).

The resilience strategy carefully mirrors what was done in the Netherlands and in the Chesapeake Bay Region, but incorporates active discussion and research on resilience into all aspects of city and regional planning. For example, the plan strives to define and expand resilience beyond just simple flood protection, including addressing ways to advance coastal restoration for the larger benefit of the metropolitan area by investing in comprehensive and innovative urban water management strategies. Additionally, the plan actively takes a qualitative approach to include the involvement of all stakeholders—especially residents—by encouraging them to actively become involved in the creation of a culture of environmental awareness and to commit to the mitigation measure of a regional climate impact. The plan cites the importance of restoring and protecting the coastal areas surrounding the City of New Orleans as being pertinent to reducing flood risk, protecting important assets of the city's economy, and providing ongoing protection to mitigate the risks of losing invaluable habitats for various forms of wildlife unique to the region, as well as recreational areas (City of New Orleans, 2015).

What will be needed moving forward is the adaptation of coastal wetland restoration programs for the protection of the city and region from storm tides, as well as for the greater benefit of the economy, especially in seafood industries. *Resilience 2030* acknowledges that the local environment is changing, and these changes are being accelerated by climate change. The rapid loss of coastal wetlands puts extra stress on the city's flood protection system, while increases in development are impervious cover that is unable to absorb water (City of New Orleans, 2015).

Over the course of the last century, coastal wetland loss has been accelerated by the construction of levees and increased channelization of the Mississippi River. In fact, the State of Louisiana loses more than 16 square miles of wetland area each year, and the existence of the

extensive levee system around Greater New Orleans—while providing flood protection—also exacerbates this loss due to the levees' tendency to deprive the Delta Region of the necessary sediment to build new wetlands. Likewise, due to industry in the region, the carving of various canals and placement of pipelines has done a great deal of harm to the natural environment, in destabilizing marshes by allowing for more saltwater intrusion (City of New Orleans, 2015).

Recent efforts by the Louisiana Coastal Protection and Restoration Authority have the support of the City of New Orleans. Through partnerships, the City will help to advance coastal restoration and protection projects in Orleans Parish that provide flood protection, habitat restoration, and employment opportunities for the larger community (City of New Orleans 2015). As part of the 2012 Coastal Master Plan set forth by the Coastal Protection and Restoration Authority, $50 billion will be invested over the next 50 years toward not only fortifying levees and floodwalls, but also restoring wetlands and barrier islands to build multiple lines of flood protection. The Master Plan cites that without action, more than 1800 square miles of coastal land area surrounding the City of New Orleans will be lost (City of New Orleans, 2015).

Already, since 1932 there have been 1,900 square miles of coastal land lost, as a result of anthropogenic changes in the Mississippi River Delta in Mississippi and South Louisiana. Channelization of the Mississippi River began as early as the 19th century, and the research presented by the Louisiana Coastal Protection and Restoration Authority illustrates that this channelization deprived Southeast Louisiana of the needed sediment that builds coastal wetlands. Additionally, the most prominent industries in the region have done a great deal of damage in dredging canals in altering formerly existing wetland areas to make way for drainage canals and pipelines (City of New Orleans, 2015). As a result of such anthropogenic changes, saltwater

intrusion further damages the wetland ecosystems by killing native vegetation—thus exacerbating the effects of storm tides.

In analyzing the findings presented by the Coastal Protection and Restoration Authority, research presented by Mark Schuerch of the University of Lincoln in the United Kingdom demonstrates that the stability of wetlands ecosystems is in fact enhanced by human interactions. As such, he presents a global, all-encompassing strategy that considers the stability of coastal wetlands to build up vertically by sediment accretion and to preserve themselves by allowing sediments and vegetation to make use of available space (Mark Schuerch et. al, 2018). Essentially, this strategy holds that by restricting development along the coast and leaving open space for vertical (inland) sediment accretion from the immediate shoreline, wetland areas can sustain themselves even through increases in sea-level rise; the land restricted from being development is deemed as accommodation space, due to it essentially accommodating the accumulation of sediment. He postulates that current research proves to be lacking in that large-scale assessments fail to consider the biophysical feedback mechanisms and represent accommodation space—which is the vertical and lateral space that is available for fine sediments to accumulate and be colonized by wetland vegetation. More so, Schuerch concludes that coastal barriers do in fact pose a greater threat to wetland ecosystems than sea-level rise alone, because the ways in which such anthropogenic barriers—structures—are constructed do a great deal to prevent wetlands from making use of accommodation space and moving further inland (Schuerch et. al 2018).

Having utilized a model that was based on the construction of coastal typologies for over 12,000 coastline segments, Schuerch was able to successfully construct a model that depicted the effects of different heights of sea-level rise on wetland areas. Having accounted for low, middle,

and high sea-level rise scenarios, they concluded that higher population density thresholds near the coastline correlated to more accommodation space being available for wetlands to migrate inland, whereas lower population density thresholds were linked to wetlands having less accommodation space and a subsequent loss of coastal wetland area. Theoretically, this is sensible considering that if there were limits on population density along coastlines, this would prevent expansion into territory that could become wetlands in the future. Using these projections, Schuerch and his colleagues estimate that the greatest wetland loss in the world is likely to occur along the Southeastern U.S. coastline, in the Caribbean region, and in Southeast Asia (Schuerch et. al, 2018).

Expanding upon their findings, they estimate that if slightly more than one-third of coastal wetlands are given accommodation space sediment supplies remain constant, wetland (globally-speaking) have the potential to gain up to 60% of their current area. Above all, Schuerch and his colleagues recommend that research and policy incorporate nature-based adaptation solutions and policies that allow tidal wetlands to migrate inland due to changes in sea level. The benefits associated with such policies include an enhancement of the persistence and performance of the world's wetlands, in addition to increased protection from natural threats like storm surges through the relocation of flood defenses and the designation of buffers in areas surrounding coastal wetlands.

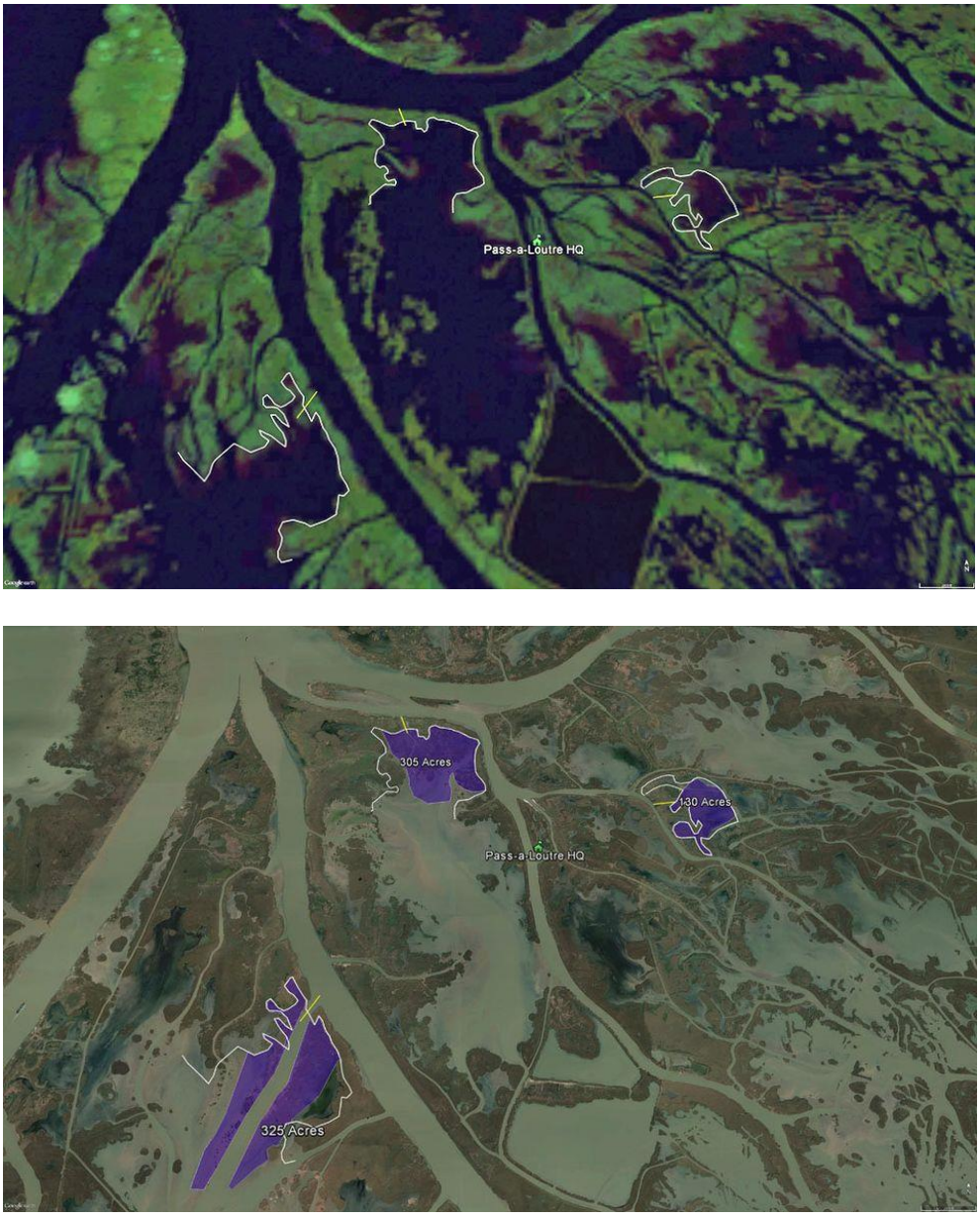
Further illustrating these arguments, the 2012 Coastal Master Plan devises ways through which the Mississippi River could be diverted as a means of restoring the rapidly deteriorating wetlands. However, such suggestions come with ample concerns—most notably, that such river diversions will actually lead to further erosion of land area, which increased in recent decades following repeated hurricanes. Researcher Alexander Kolker, a coastal geologist and Associate

Professor with the Louisiana Universities Marine Consortium, noted that his own research team conducted studies in nearby Plaquemines Parish, Louisiana, where many of the Master Plan's diversions are planned to be located, to evaluate whether river diversions lead to the creation of more land. Plaquemines Parish is located to the southeast of the City of New Orleans and encompasses the last 70 miles of the Mississippi River before it deposits into the Gulf of Mexico. One such diversion known as Cubit's Gap formed when a local fisherwoman cut a large gap in the Mississippi River levee (Kolker, 2018). From this, 75 square miles of land were built in less than a century, creating a large network of marshes extending from nearby Barataria Bay.

Using satellite images to determine whether the diverted river water can actually create stable land, Kolker's team found that the wetlands closest to the river levee where the gap had been cut were the ones that were creating land. In fact, these had the strongest soils and those with the most minerals; interestingly, these wetland areas actually consisted of freshwater. Those wetlands that had large quantities of eroding land were furthest from the Mississippi River, and thus furthest from the diversion in the levee. Much of the water in those wetlands was high in salinity (Kolker, 2018). As a result, Kolker concluded that the key to building stable land in a river diversion is to ensure that ample amounts of sediment is delivered to marshes.

The Louisiana Crevasse Project—implemented in 1986 by the Louisiana Department of Wildlife and Fisheries—successfully cut three crevasses on natural levees in the Pass a Loutre Wildlife Management Area, which is also located just south of New Orleans in Plaquemines Parish. While it was expected that the crevasses would produce land for only 10 to 20 years, research reveals that they are still producing land and will continue to do so for the next decade. To date, such crevasses have been credited with generating as much as 760 acres of land. Such

successes speak positively to the gains that can be expected from cuts to be made in levees in the parish over the next decade as part of the 2012 Coastal Master Plan (Masson, 2016).



The first image depicts the area of wetlands near Pass-a-Loutre, Louisiana—just south of Venice, LA—in Plaquemines Parish just after three crevasses were cut into natural levees in the area. The second image was captured via satellite in 2016, illustrating how much acreage has been created in the thirty years since the cutting of crevasses.

Sources: Louisiana Department of Wildlife & Fisheries, 1986, 2016; Todd Masson, 2016, New Orleans Times-Picayune

According to the Louisiana Department of Wildlife and Fisheries, the land re-generation that occurs through the cutting of crevasses into the levees results primarily from the passage of sediment-laden water into interior marshes and ponds. With the passage of time, sediment accretion happens in the same ways in which it did for centuries prior to the channelization of the

Mississippi River. With the accretion, or build-up of sediment, open water areas high in salinity begin transforming to healthy, freshwater marshes. Thus, instead of land eroding away, it is being created on its own at varying elevations that allows for more diversity in the types of species that can access the newly-created habitats. Areas that were once open marshes and bays are now home to a wide variety of habitats, such as tidal mudflats, as well as fresh marsh and emergent vegetation—all of which provide protection for coastal areas. The tangible environmental benefits of the emergence of these habitats include marine fisheries, nesting habitats for alligators, and habitats for other animals such as white-tailed deer and rabbits.

Emergent vegetation in the newly formed marshes was slow, but came gradually with the shallowing of the area through sediment accretion. Within a few years following the cutting of holes into the levees, channels began to form along the water bottom with submerged aquatic vegetation. As sediment formation continues, so does the formation of tidal vegetation in place, including delta duck potato and cattails, in areas where there was previously only submerged aquatic vegetation. Continued sediment accretion leads to elevation changes in the area that allow for willow and woody vegetation to take root. With such transformations, the impact of the crevasses takes root; likewise, more vegetation expands into new areas that were also previously submerged by saltwater (Masson, 2016).

What was also monumental about the Louisiana Crevasse Project is its low cost. Much of the funding was allocated through the Coastal Environment Protection Trust Fund. At the time, the State of Louisiana only budgeted $300,000 for the project, which worried some as there was no guarantee of how successful the initiative would be. By the time that the crevasses had been cut in the levees, the contractors only had only spent $88,000 of that allotment. Thus, while the project was initially thought to have been under-funded, the results illustrates that it came in well

under the state's budget while simultaneously over-delivering. The creation of mash areas in the in the Pass-a-Loutre has generated land that only amounts to a cost of $115 per acre.

In addition to strategies to build land outside the city, recent actions by the City of New Orleans have incentivized water management on urban parcels within the city limits. In partnering with Deutsche Bank-Alliance NRG, the City of New Orleans actively calls for the development of a resilience retrofit program to provide incentives for city property owners to reduce their own risks of flooding. Thus, homeowners and business owners can easily have access to necessary resources to adapt to changes in the natural environment. For example, the plan suggests the adoption of rain gardens for improved storm water management on individual property parcels. In addition, it suggests that homeowners and business owners incorporate standards for resilient home design, such as home elevation to eliminate the risk of flooding. Both strategies prove to be sustainable options that homeowners can take to protect their most valuable investments (City of New Orleans, 2015).

The city's willingness to partner with external stakeholders to actively devise ways in which homeowners can invest in sustainable strategies at minimal costs illustrates the benefits of public-private partnerships toward improving carrying out the goals of planning that is truly resilient and sustainable. One such initiative is the PACE (Property Assessed Clean Energy) Initiative, through which property owners can make energy efficiency improvements to their homes at minimal costs with loans repaid through property tax bill over a 20-year time span. Provision of capital at low-interest gives homeowners an opportunity to invest in improvements to make their homes more resilient to storm damage (City of New Orleans, 2015). Interestingly, while PACE was initially developed to improve energy efficiency, it has evolved in its use for structural strengthening of buildings to better withstand storms.

The strategy employed by the City of New Orleans expands from resilience planning as it is traditionally defined. Generally, resilience planning for coastal cities is centered on environmental adjustments to planning and development. By contrast, the strategy employed by New Orleans creatively moves to include other aspects of resilience planning into its framework for improving the state of the city and region as a whole for residents and visitors alike. What becomes apparent upon examining the city's resilience strategy is the interconnected nature of environmental resilience and sustainability to other aspects of municipal and regional sustenance. Additionally, the City of New Orleans has engaged in active efforts with stakeholders from other state and local entities to ensure that making the goals of the plan come to fruition—a strategy that could be implemented in other coastal cities, especially where city and state officials often find themselves in conflict with one another for various reasons.

The strategy employed by the City of New Orleans embodies true collaboration among a variety of stakeholders in planning for resilience and sustainability, and it illustrates how there are several components toward planning for resilience, which are separate, but nevertheless interconnected. Divided into four dimensions, the plan seeks to promote the well-being of the community by assessing the connections between existing challenges, identifying critical areas of weaknesses, and the development of action strategies that build upon existing strengths. The breakdown of the City Resilience Framework is provided below, in addition to 12 associated drivers of resilience.

Infrastructure & Environment	Economy & Society	Health & Well-Being	Leadership & Strategy
Provide reliable communications and mobility	Foster economic prosperity	Meet basic needs	Promote leadership & effective management
Ensure continuity of critical services	Ensure social stability, security, & justice	Support livelihoods & employment	Empower a broad range of stakeholders
Maintain and enhance natural and man-made assets	Promote cohesive & engaged communities	Ensure public health services	Foster long-term & integrated planning

Source: Resilience 2030 Strategy, City of New Orleans, 2015

Planning for environmental and infrastructure resilience only encompasses a fraction of the city's resilience strategy. Within environmental and infrastructure planning, the city's strategy seeks to implement ways for improved transportation and mobility in addition to municipal response strategies. The plan also illustrates that there are varied levels to critical infrastructure, including inhabitation and land cover, infrastructure networks, as well as infrastructure pertaining to soils, water, and biodiversity. What is evident is that sustainable infrastructure involves more than just levees and floodwalls to protect property from flooding, as well as drainage canals and bridges. What is interesting about the infrastructure and environment is that the goals are interrelated with other categories through which resilience measures are defined. Further illustrated in all categories of New Orleans' resilience framework are the ways in which truly resilient planning is embodied by economic sustainability, social improvement initiatives, municipal managements, and quality of life indicators—all of which intermingled as part of a unique resilient framework (City of New Orleans, 2015).

The strategy employed by the City of New Orleans and various other agencies in South Louisiana is notable in that collaboration among various stakeholders with varying interests becomes a major factor in ensuring the success of the plan. For example, the 2012 Coastal

Master Plan employed by the Louisiana Coastal Protection and Restoration Authority is one of many frameworks designed to plan for the region's increasing vulnerability to coastal erosion and flooding. Founded by the Louisiana Legislature in the aftermaths of Hurricanes Katrina and Rita in 2005, the organization is responsible for overseeing coastal wetland restoration and hurricane defense projects in the State of Louisiana. In 2017, several parishes to the south and west of New Orleans were awarded up to $41 million in federal grant money for flood resilience projects through Louisiana's Strategic Adaptations for Future Environments Plan—also known as LA SAFE—which was created to provide long-term assistance to the region after the devastation resulting from Hurricane Isaac in 2012. Approved funding will provide for a variety of resilience and sustainability initiatives, including the construction of safer roads in some parishes, as well as the permanent relocation of residents from low-lying areas along the immediate coastline, most notably in Terrebonne Parish (Hardy, 2018).

Additionally, funds allotted to nearby Lafourche Parish through the U.S. Department of Housing and Urban Development will assist in retrofitting existing structures in various communities and designing new communities to be wind- and water-resistant amidst changes in sea level. Such changes in building design include elevating the living spaces of homes on pier-and-beam foundations to allow for vehicular parking beneath the structures, while simultaneously incorporating the installation of solar panels, road and transportation infrastructure with permeable paving, improved and integrated retention basins for storm water and recreational purposes, as well as complete streets with bump-outs, bioswales, and trees (Foundation for Louisiana, 2018).

Housing Resilience in New Orleans

While the aforementioned plans actively incorporate housing into the resilience discussion, efforts in the City of New Orleans that could be incorporated elsewhere illustrate the importance of the involvement of the citizen body and political stakeholders in making a city sustainable in terms of its housing stock. In other words, citizens and local political players are truly responsible for carrying out and implementing plans for resilience and sustainability in housing and related policy, which will be explored later in this section.

In the years following Hurricane Katrina in 2005, the City of New Orleans has witnessed significant increases in housing costs, which has unfortunately made the city increasingly unaffordable for low- and middle-income persons, often resulting in residential displacement. When the storm made landfall, it killed 1,800 people along the U.S. Gulf Coast and flooded nearly 80% of the city for weeks. Ten years after the storm, the federal government had spent billions of dollars to rebuild communities along the coast; at the same time, the State of Louisiana had spent $10 billion in recovery money for the purposes of reconstruction (Singer, 2015).

In the years following Hurricane Katrina, residential displacement in New Orleans was most immediately felt by low-income residents following the city's decision not to reopen and to demolish several of the largest public housing developments. While the rehabilitation of these housing developments would not have been extraordinarily costly given that the storm had not done any structural damage, city officials and the United State Department of Housing and Urban Development proceeded with the demolition despite outcry and legal action taken on behalf of the developments' former residents (Goetz, 2013; Sinel, 2016). In terms of New Orleans' socioeconomic and demographic makeup, this set an alarming precedent considering

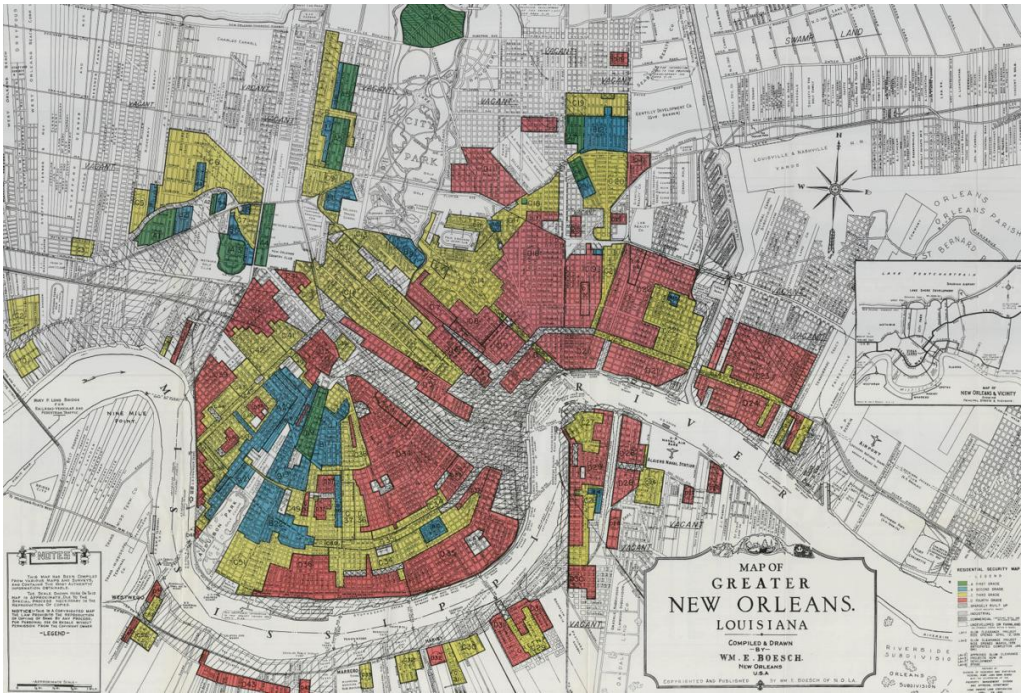
that pre-Katrina New Orleans consisted of a large rental population, which "disproportionately needed low-income or subsidized housing…[and who did not] control the rebuilding of their housing units" (Lisa K. Bates, 2006).

In the more than ten years since Hurricane Katrina, the population of New Orleans has become increasingly affluent, putting a strain on the availability of affordable housing for many of the city's working poor. Many of the city's low-income workers have been priced out of the area's closest to the economic center and historic core—an area where affordable, and frankly cheap, housing was often abundant, albeit substandard, in previous decades. Given the proximity that these housing options provided for low-income individuals to jobs, many were able to take much-needed advantage of living without vehicular transportation and rely on the city's public transportation (Robert McClendon, 2015). It is not far-fetched to assert that the working-poor and middle class in New Orleans have become economically strained, living in a city with rising housing costs and stagnant wages. In fact, housing advocates fear the future of the city being one where the working-poor are virtually non-existent. Flozell Daniels, Jr., Chief Executive of the Foundation for Louisiana, noted, "[We have] been talking about the rising home values and new people moving into town, and it is reported on like it [is] great news, and it absolutely is; but it also presents certain challenges for those at the bottom" (Robert McClendon, 2015).

There were plans for the prioritization of tourism development, with entrepreneurs being offered large tax incentives to invest in the city (Beth J. Harpaz, 2015). Many believe that the years of rebuilding post-Katrina rebuilding efforts intentionally locked the working-class and most vulnerable residents out of returning to their homes in the city. For example, in a September 2005 opinion piece written in the New York Times, the columnist David Brooks, when speaking of opportunities that present themselves in all crises, wrote that "if we just put up new buildings

and allow the same people to move back into their old neighborhoods, then urban New Orleans will become just as rundown and dysfunctional as before". Brooks continued that, asserting that "[another] rule of rebuilding should be: culturally integrate…the only chance we have to break the cycle of poverty is to integrate people who lack middle-class skills into neighborhoods with people who possess these skills and who insist on certain standards of behavior" (David Brooks, 2005). Nevertheless, analyzing the existing affordability crisis in New Orleans today, it is clear that this never happened.

During the city's recovery, the Road Home Program was enacted by the State of Louisiana to assist residents in rebuilding their homes. The program, which was largely an effort of the State of Louisiana through its Recovery Authority and in partnership with the United States Department of Housing and Urban Development, could have done more damage to working-class residents and further perpetuated inequity. The program was designed to ensure that all Louisianans displaced by the devastating storms of the 2005 Atlantic Hurricane Season would have the opportunity to return home. However, assistance payments for hurricane victims were calculated based on the lower of two figures—the pre-storm market value of a home, or the cost to repair the storm-induced damage to the home. Under such circumstances, property owners living in areas of the city where property values were depressed due to a history of economic redlining and other discriminatory practices, were assessed according to the pre-storm market values of their homes and consequently slated to receive less assistance in funding. By contrast, property owners, who lived in areas where their parcels were appraised at higher rates, received more monetary assistance toward rebuilding their homes, and thus, were more likely to return. African American homeowners in New Orleans were more likely to receive payouts based on depressed home values (Perry, 2010).

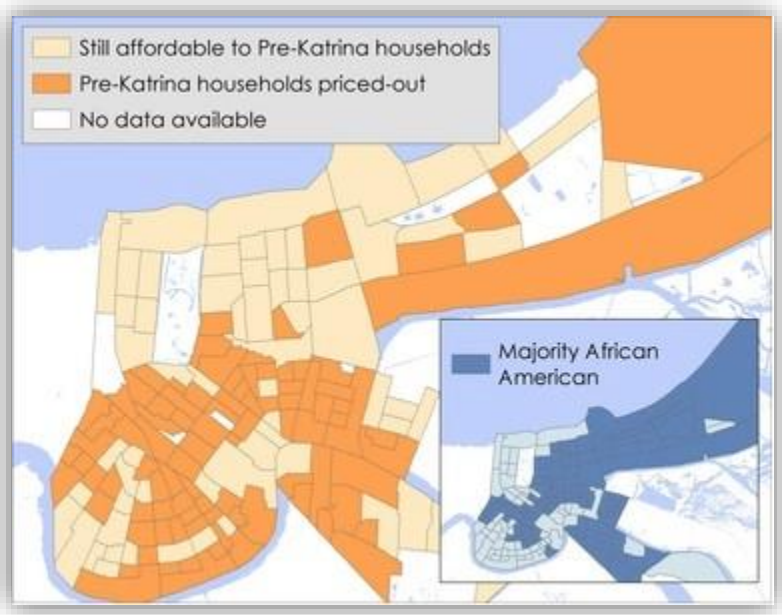


"The impact of redlining — in which lower-income families had been denied access to credit based on their race — stamps through New Orleans' geography. It built the city's modern-day housing market, and the areas defined by its lines still suffer from its invention."

Source: Alex Woodward, The New Orleans Advocate, January 2019

According to data released by the Greater New Orleans Fair Housing Action Center (GNOFHAC) in 2015, housing costs consumed an increasing portion of budgets for renters in the city, sometimes consuming as much as 50% or more of their monthly income. While this is common in many cities, what is important to note about New Orleans is that such increases illustrate how changes in the rental market overwhelm families in the city. Since Hurricane Katrina, rents in the city have risen over 50%, and a majority of renter households (nearly 62%) were cost-burdened in 2015, meaning that they spend more than 30% of their monthly income on housing costs — rent plus utilities. Housing costs have grown overtime due to rising rents and static income (Housing NOLA, 2015; Asakura Robinson Company et. Al, 2018). Despite post-hurricane population recovery that contrasts with the city's decades-long decline, much of the

lack of available housing was largely due to a large share of it being taken off the market as a result of Katrina. The failure of federal authorities to have a disaster housing plan in place before the hurricane, coupled with the reality that many of the city's renters lived in properties owned by landlords who were also unable to return, exacerbates the housing crisis (McClendon, 2015). In comparing data illustrating income data from 2000 with data collected on rental rates between 2009 and 2013, it becomes apparent that many pre-Katrina residents are unable to afford housing costs in their former neighborhoods, and many of these neighborhoods were areas that were previously African-American (McClendon, 2015).



Source: Greater New Orleans Fair Housing Action Center; Robert McClendon, The Times-Picayune, 2015

GNOFHAC Executive Director Cashauna Hill has offered a variety of policy suggestions that could mitigate displacement associated with influxes from new investment. First, she notes that government should focus on developing affordable housing on the properties that it owns, especially in neighborhoods where high-market demand is driving up prices. Secondly, federal grants for economic development and beautification projects in areas that are likely to transition

in their demographic makeup need to be paired with housing programs to allow renters and homeowners to stay in place as communities undergo economic transition and aesthetic improvements. Lastly, she stresses the importance of zoning policies that encourage affordable housing construction as well as strong Neighborhood Housing Improvement Funds (McClendon, 2015).

Examining the Actions in the Policy Debate Surrounding Housing Resilience in New Orleans

Interestingly, local leaders in New Orleans have heard the calls for policy to address the increasing lack of affordable housing in the city. Likewise, data supplied by housing advocates, such as the Greater New Orleans Fair Housing Advocacy Center and the New Orleans Data Center, illustrates that the lack of affordable housing in the city and resulting displacement has turned into a crisis, which could be viewed as part of the larger emerging income inequality crisis seen nationwide. Consequently in 2018, the Greater New Orleans Housing Alliance (GNOHA) has partnered with other affordable housing advocates in the city to launch the *Put Housing First* Campaign. According to information provided by the GNOHA, the campaign seeks to "secure the support of 80,000 people who stand behind the advocacy efforts of the GNOHA and demand that [city] leaders prioritize safe, affordable, healthy housing for all in [the city of] New Orleans" (Greater New Orleans Housing Alliance, 2018).

In 2018, local advocacy groups were vocal in urging local leaders to approve Motion M-19-73 which presses the City to update density bonuses, height limits, and additional affordable housing requirements in certain neighborhoods to support the initiatives contained in the city's Smart Housing Mix and Housing NOLA's "10-Year Strategy Implementation Plan." City Councilmember Kristin Gisleson Palmer introduced amendments that would greatly incentivize quality developments along the riverfront and help to combat the city's current affordability

crisis. As a result of advocacy efforts, the New Orleans City Council has agreed that renting and purchasing homes in the city has become exceedingly expensive for low-income residents. City Council President Jason Williams said of the crisis, "The clock is ticking, and we could very easily find ourselves in a situation where we [cannot] do what is best for New Orleanians…We cannot be the New Orleans [that] we have been and want to be if our musicians, our hospitality workers, [and] our New Orleans police officers [cannot] afford to buy housing in the city" (Litten, 2019).

Work done by advocacy groups has not been in vain; the City Council has agreed that there is not enough existing affordable housing to meet such demands. The Office of Mayor LaToya Cantrell actively began studying development incentives, but acknowledged that more research needs to be completed before adopting set-aside requirements for affordable housing, such as tax breaks, creative financing options, and density bonuses. Much to the chagrin of some local developers, in January 2019, New Orleans' City Council began taking steps toward voting on an inclusionary zoning policy that would require developers to include affordable housing units. This comes at a time when Governor John Bel Edwards of Louisiana has indicated that he would not veto a proposed state law that would ban local governments from requiring developers to include affordable housing (Litten, 2019). Some developers have opposed an inclusionary zoning ordinance, arguing that it could interfere with the real estate market and stifle development. Nevertheless, city council approved three planning commission recommendations for further study, including:

- Creating a "mandatory inclusionary zoning overlay district" where the city identifies demand for affordable and workforce housing, through which developers have the

opportunity to apply to construct structures larger than the zoning allows if they commit to including affordable housing units.

- Creating a "mandatory inclusionary base zoning district."
- Creating a planned development classification that requires affordable housing by allowing a developer to seek suspension of restrictive zoning codes in exchange for working with city planners to incorporate affordable and workforce housing (Litten, 2019).

According to Housing NOLA, the push for the incorporation of mandatory inclusionary zoning is an important step for the New Orleans housing market. At present, the organization stressed the need for the city council to pass a motion that will require private developers to create affordable housing when developing new properties in the city. Such policies ensure that developers have a clear opportunity to include affordable housing (Housing NOLA, 2019). Furthermore, the organization notes that the current lack of mandatory inclusionary zoning creates an uneven playing field for developers as well.

Nevertheless, Housing First cites that inclusionary zoning is needed in the city, primarily due to the inability of the market to self-correct. At present, market rate developers can only afford to construct new housing for higher-income buyers, because this will provide them with a way to recoup their funds from the development, as well as repay any incurred costs and debts owed to investors. Similarly, research presented by the New Orleans Data Center in conjunction with Tulane and Dillard Universities, as well as the Greater New Orleans Fair Housing Action Center, indicates that mandatory inclusionary zoning policies can be a way to tackle economic segregation—much of which is rooted in the city's history of targeted discrimination and segregation in housing policy—and ensure that affordable housing is within reach of public

transit, retail outlets, and quality jobs. Furthermore, the advocacy group notes that the importance of incorporating mandatory inclusionary zoning comes at a time of low spending on federal housing programs. Given that these shortages of funds are projected to continue over the next several years, existing voluntary incentives that the city offers to developers will be strained and incongruous with market demands (Housing NOLA, 2019).

Residential displacement resulting from development pressures can be linked with the inability of existing property owners in transitioning areas to pay their property taxes due to drastic and sudden rises (Way et. al, 2018). Consequently, New Orleans City Council has called on the State Legislature to consider the passage of an amendment to the State Constitution to assist residents who are struggling to remain in their neighborhoods as a result of tax increases that are linked to development and gentrification pressures. Proposals made by the City Council would stand to benefit residents who have tax bills that have doubled within the last year, and have also lived in the city since 2004 and meet low- and moderate-incomes.

It appears that those who stand to benefit from the proposed policy are residents who were part of New Orleans' pre-Katrina population and are struggling to remain in their homes and communities as a result of development-induced pressures. Sources cite that increases in property taxes facing New Orleans residents are due in part to the process of house-flipping, in which investors purchase older, sometimes dilapidated properties and invest ample money into renovating them in order to sell them for a fast profit. As a result of the presence of short-term rentals in the city, such as Airbnb, this process has become increasingly common throughout many neighborhoods in the city (Williams, 2019).

According to New Orleans City Council Member Jay H. Banks, the Louisiana State Legislature has reason to pass the amendment based on the fact that it does not exact damage on

the wealthy investors in these communities nor does it "penalize people who have been living in neighborhoods [for] their whole lives" and are not wealthy (Williams, 2019). State Senator J.P. Morrell, a Democrat from New Orleans, led a separate, successful tax relief effort in 2018, and he has asserted that getting another relief measure passed in the state could be difficult within such a short amount of time. Nevertheless, he asserted that the previous measure had been put into place to assist homeowners in Lake Charles and New Orleans, indicating that there is an affordability crisis throughout the state.

The city council is also advocating that the measure should be targeted at those who do not earn more than 120% of the area's median income. Based on last year's income statistics, this would have benefited a family of four with an income up to $78,720. The measure has received support from other housing advocacy groups, including Housing NOLA—a ten-year partnership between community leaders and several public, private, and nonprofit organizations working to resolve New Orleans' affordable housing crisis—in addition to some of the other city councilmembers (Williams, 2019).

Protesters stand with signs in front of City Hall in New Orleans to oppose the Short-Term Rental Ban, January 10, 2019
Source: Sophia Germer, The New Orleans Advocate

At the same time, City Council also began imposing limits on short-term rentals, which have exacerbated increases in property values for local residents. In early 2019, the City Council took steps toward dramatically reducing the number of short-term rentals that are allowed to operate in the city, proceeding with initiatives to require an owner to live on the site of any residential property parcel that is being rented to tourists. As a result, the city council advanced several regulations that would make it illegal to convert residential investment properties into short-term rentals, and supported the imposition of bans on short-term rentals in most of the French Quarter and the Garden District in Uptown New Orleans. Concurrent with these revelations was a call to the City Planning Department to implement policies could be to allow profits from short-term rentals to increase the supply of affordable housing in the city (Adelson, 2019). Other measures set forth by the city council in the same meeting urged the Mayor's Office to devise plans to improve enforcement of existing city rules. Such improvements could include measures that consolidate short-term rental enforcement into a single city department and requiring platforms, such as Airbnb, to share their requirements with the city. Furthermore, city council has called on the City Planning Commission to investigate if specific rules should apply to specific areas in the city (Adelson, 2019).

> *"Our job is to provide a place for our residents, and that can't happen while our neighborhoods are sold to the highest bidder."*
>
> Kristin Gisleson Palmer, New Orleans City Council

The Housing Authority of New Orleans and the New Orleans Redevelopment Authority have also been a major force in recent efforts to combat the city's affordable housing crisis. Between December 2018 and January 2019, the organizations, commonly referred to as HANO and NORA, selected several developers to construct affordable single-family housing in the city's Lower 9th Ward—an area just east of the Industrial Canal that witnessed some of the worst devastation from Hurricane Katrina in 2005—and began reviewing proposals for more affordable housing in the Upper 9th Ward and in Algiers on the city's west bank. There were four developers selected for the construction projects in the area, and they will be responsible for developing 16 vacant properties for rehabilitation near the Dr. Martin Luther King Charter School. The properties were made available through the Redevelopment Authority as part of its Orleans Housing Investment Program, which has been providing subsidies for investors who are willing to build affordable single-family homes for purchase (Williams, 2019).

Address	Price:
2117 Andry Street	$2,500 EACH
2120 Andry Street	
2139 Andry Street	
2217 Andry Street	
2223 Andry Street	
2227 Andry Street	
2239 Andry Street	
2301 Andry Street	
2333 Andry Street	
2335 Andry Street	
2439 Andry Street	
2541 Andry Street	
5401 N. Dorgenois Street	
5415 N. Galvez Street	
5415 N. Miro Street	

Developers have been selected to develop affordable single-family housing on 16 lots owned by the New Orleans Redevelopment Authority.

Source: The New Orleans Advocate

Prior to Hurricane Katrina, the Lower 9th Ward maintained one of the highest rates of black homeownership in the city and has been in dire need of more investment since then. Housing advocates have asserted that the Housing Investment Program operated by NORA is a positive way to increase the area's population and attract more private investment. Developers will be allowed to strategically purchase the lots for 10% of their fair market value, or $2,500—whichever is greater. Afterward, NORA will then provide low-interest loans of as much as $100,000 per property to construct the homes. Up to as much as $75,000 of each loan can be forgiven. All of this is contingent upon developers actively working with real estate agents to find buyers for the properties. NORA has stipulated that prospective homebuyers, who earn no more than 80% of the area's median income, can receive at least 25,000 in down payment assistance. Eligibility requirements also extend to families who earn up to 120% of the area median income, which translates to $78,720 for a family of four (Williams, 2019).

Similarly in Algiers and the Upper 9th Ward—two different sections of the city that were the former sites of two public housing developments that were demolished following Hurricane Katrina, the Housing Authority of New Orleans is evaluating plans for what could become future sites for mixed-income housing. Additionally, the organization is also evaluating the possibility of rehabilitating several abandoned properties in the city's Uptown neighborhood for both sale and rent. Such efforts comprise a larger strategy of the organization to avoid high concentrations of poverty in city neighborhoods by developing properties that offer cheaper and market-rate units (Williams, 2019). By the same token, the Housing Authority has recently completed similar new developments in other areas of the city that were damaged by Katrina and currently taking applications for scattered site apartments around the city, including in the Florida Neighborhood near the Upper 9th Ward, as well as Uptown and on the West Bank (Williams, 2016).

What the aforementioned illustrates is an effort by the Housing Authority to provide affordable housing in post-Katrina New Orleans after unfairly deciding to eradicate functional public housing developments. Interestingly, the city's decision to eradicate public housing was largely driven by federal policies. What is rarely mentioned in the discussion is the local stigma that remains associated with the city's public housing developments of being havens for crime and social degradation. Given the city's history of ethnic and economic biases against certain communities, there is no doubt that such prejudices were largely reflected in the decision to reinstate public housing in the city. Furthermore, what such biases fail to consider is that the poverty and related symptoms that became associated with such developments prior to the storm was largely the result of decades-long urban disinvestment. Despite the efforts of the Housing Authority and the Redevelopment Authority to combat the city's affordable housing crisis, it is still obvious that little of the city's public housing—which was exclusively for poor New Orleanians—has been restored since the storm. Mixed-income development provides a certain percentage of housing for families living below the poverty threshold.

While the concept of mixed-income development is monumental and commendable on the part of both agencies, this is still not enough, and such efforts come at a time when the need for affordable housing in New Orleans is so great that such development cannot keep up with the demand. Had City of New Orleans officials truly devised an inclusive strategy to enable the city's residents to return following Hurricane Katrina in 2005, perhaps the development of affordable housing for the working class would have been considered, lessening the likelihood that this issue would be plaguing the city at this scale. However, this was not the case. In fact, evidence presented illustrates existing systemic biases in who was allowed to return and which sections of the city were given priority in their redevelopment.

Moving Forward

Considerable strides have been made toward incorporating sustainability and resilience into urban planning in New Orleans and South Louisiana. Relating to affordable housing, it is apparent that in the immediate aftermath of Hurricane Katrina, actions taken by government and business leaders in New Orleans were very antagonistic to the city's working class, especially with the demolition of the city's structurally sound public housing developments and the ways in which certain communities were prioritized over others in the recovery process. Nevertheless, a combination of factors in New Orleans today has reversed this trend, and through the works of advocacy groups and policymakers, affordable housing provision has largely become an intricate part of the city's sustainability matrix.

On a broad level, it is apparent how officials in various levels of government collaborated with other stakeholders, including scientists, real estate developers, and businessmen, to research the incorporation of sustainability and resilience into planning practices. What resulted were several plans on both the city and state levels to not only protect the natural environment, but to also examine the ways in which existing structures—be they political or physical—are failing to enhance the quality of life for residents and sustainable growth and prosperity of the region. The efforts undertaken in New Orleans and throughout South Louisiana toward incorporating sustainability and resilience into planning can serve as models for other cities and regions. The following items demonstrate the most important takeaways that stakeholders in other cities and regions should consider when attempting to do the same in their communities:

- Foster collaboration between state-level agencies and higher-forms of government to ensure that funding is available to areas in need of resilience- and sustainability-based action.

- Increase collaboration to produce state-level climate action plans that highlight the importance of partnerships between all levels of government, including government on the municipal, state, and federal levels.
- Devise a stable way to engage stakeholders on all levels to better understand how changes in the natural, built, and economic environments can affect decision-making processes.
- Devise and implement improvements for additional land and water management strategies.
- Have groups present to actively evaluate the existing regional and municipal conditions; continue to inform policymakers.
- Foster collaboration between government (both state and city) and non-partisan research entities to ensure that policymakers are informed about existing regional conditions pertaining to resilience and sustainability in the housing and environmental areas.
- Foreground the importance of having civic organizations speak on behalf of the residents to address their concerns with failures toward sustainability and resilience in planning; further; these groups must represent citizens when putting pressure on policymakers.
- Push legislative bodies to take policy-based action toward incorporating resilience frameworks.
- Educate laypeople on the importance of resilience frameworks.

Regional Environmental Sustainability

The Galveston Bay Watershed and its Importance

Given Galveston's position on a barrier island and at the mouth of a large bay, it would be irresponsible to discuss environmental resilience and sustainability without adequately analyzing existing research on the health of the overall Galveston Bay Watershed and Estuary System, which spans a large portion of the Upper Texas Coast. The City of Galveston can implement changes to existing policy to foster environmental resilience and sustainability, but ultimately, this must be part a concerted regional effort in order to ensure its success. Similar to New Orleans, the City has the opportunity to take advantage of existing research conducted by local universities and government officials, as well as ample sustainability- and resilience-oriented discussions on best practices. Such research can be incorporated into practice to improve the region's level of environmental resilience sustainability as many cities throughout the region are faced with continued growth over the next several decades.

While Galveston is an extremely small city in comparison to the city used as a primary reference in this report, its location renders it an almost perfect case-study location for implementing environmental resilience, not only in the city, but also throughout the metropolitan region. While Galveston is the larger metropolitan area's first line of defense from approaching cyclones from the Gulf of Mexico, the island's environmental health is intrinsically linked to the environmental health of areas further inland. Likewise, the environmental health of these inland, yet coastal areas is centered on the ways in which city officials—including those in Galveston and nearby communities—sustainably manage them to ensure that they continue to function. Thus, in order to truly understand what makes the entire regional ecosystem resilient and

sustainable, it is important to pay careful attention to the existing conditions and management practices of the region's wetlands.

The Importance of Wetlands

Generally, official definitions of wetlands have changed over the course of the last half-century, often reflecting attitudes and changes in political and scientific approaches to their management—or the lack thereof. With the passage of laws and regulations pertaining to wetland management at the end of the 20th century, the ways in which wetland ecosystems came to be defined became more delineated and precise (Mitsch and Gosselink, 2015). Today, wetlands can most easily be defined as ecosystems that are submerged by water either on a permanent or seasonal basis. This prolonged inundation leads to the formation of hydric soils that are dominated by oxygen-free processes, which force the vegetation to adapt to flooding. In fact, much of what distinguishes wetlands from other land forms or water bodies is the presence of these aquatic plants that have adapted to being able withstand long periods of inundation (Paul Keddy, 2016).

According to the United States Environmental Protection Agency, all tidal and non-tidal, fresh, saline, and brackish water wetlands that are located in coastal watersheds—including salt marshes, bottomland hardwood swamps, fresh marshes, seagrass beds, mangrove swamps, fresh marshes, and pocosins—comprise coastal wetlands. These are valuable resources, as they serve as providers of nurseries, shelter, and nutrient source for various types of marine life. In the United States, nearly half of all wetlands are coastal, and more than 80% of coastal wetlands are located in the Southeastern United States (Environmental Protection Agency, 2017). Researchers William Mitsch and James Gosselink have noted that wetlands are often described as "nature's kidneys" and "nature's supermarkets" to attest to their unique and vital functions for the

surrounding habitats. Throughout history, humans as a species have lived in harmony with wetland ecosystems, developing and sustaining themselves from the natural functions of wetlands, including the inhabitants of ancient Egypt along the Nile River Delta, the Marsh Arabs of southern Iraq, the Camarguais people of southern France, and more recently, the Cajuns of South Louisiana (Mitsch and Gosselink, 2015).

Nevertheless, just as many cultures have strived to sustain themselves harmoniously amidst the presence of wetlands, there are those cultures that have simply eradicated them as a means of survival. Mitsch and Gosselink's research illustrates that while wetlands are widespread, they have often been misunderstood throughout history in terms of their use and function. The misunderstandings of these ecosystem environments and their positive functions, as well as the need to alter and sometimes eliminate them for convenience, have often led to mismanagement, especially in the western world where it has only been recent in which efforts have been made to correct past damage done to wetland ecosystems (Mitsch and Gosselink, 2015).

According to Mitsch and Gosselink, wetland ecosystems function as "the downstream receivers of both human and natural wastes…stabilizing water supplies…and mitigating floods and droughts" (Mitsch and Gosselink, 2015). From this, these ecosystems serve as cleansing agents for water that have been polluted, in addition to protecting coastal shorelines and recharging groundwater aquifers. Likewise, wetland ecosystems support a vast food chain and ample biodiversity, providing a natural habitat for various types of vegetation—which has led many to consider them as global carbon sinks and stabilizers of climate throughout the world (Mitsch and Gosselink, 2015). The U.S. Environmental Protection Agency notes that "the combination of shallow water, high levels of nutrients, and primary productivity is [also] ideal

for the development of organisms that form the base of the food web and feed many species…that rely upon these ecosystems for foods" (Environmental Protection Agency, 2017).

Furthermore, research conducted by the EPA reveals the financial benefits that wetland ecosystems provide to municipalities as a result of their mere filtration functions through which they clean water, divert nutrients where needed, and filter pollutants. For example, in South Carolina, the Congaree Bottomland Hardwood Swamp has been found to remove a number of pollutants on an annual basis that is equivalent to that which would be removed by a $5 million wastewater treatment plant. Research from a 25-acre wetland in Georgia indicates that its filtration functions save the local jurisdictions up to $1 million in water abatement strategies on an annual basis (Environmental Protection Agency, 2017).

In coastal regions, perhaps some of the most important functions of wetland ecosystems are their ability to serve as natural flood protection for municipalities. Given that wetlands have lower elevations than surrounding upland areas, they are able to store and gradually release excess water—including rain, snowmelt, groundwater, and floodwaters—reducing the risks of flooding for those communities which they protect and reducing the potential for erosion downstream and on adjacent lands. The dense vegetation that is characteristic of these ecosystems assists in water flow and release, because it essentially inhibits the outward flow of water, making releases more gradual and controlled. In addition to protecting coastal areas from storm surges and excess water backlogging during flood events, wetland ecosystems and their increased abilities to store water contrast the excess runoff that occurs in cities from impervious cover.

Wetlands that lie within close proximity to shorelines aid in protecting them against erosion given that distinct vegetation aids in holding the soils in place with their roots. As a

result, plants can absorb the energy released by oncoming waves and diminish the flow of passing currents. The Environmental Protection Agency notes that the ability of wetlands to control erosion is so valuable that U.S. states have begun implementing measures to restore coastal wetlands as storm surge buffers from tropical systems by dissipating wave energy before it impacts manmade structures (Environmental Protection Agency, 2017).

Given their ample functions and the vast array of natural life that depends upon these ecosystems for sustenance, it is important to note how vulnerable they are to existing threats. While threats are numerous, research has revealed that the majority are human-induced and result from poor management and land use practices, followed by natural changes in climate. For example, throughout much of the United States, wetland ecosystems have been the sites of increased channelization, damming, and levee constructions for flood mitigation—all of which in turn did damage to these wetland areas and nullified the natural processes which they undergo to provide the same protection.

One need not look any further than the Mississippi River Delta Region, especially the Bottomlands Wetlands of this region. Historically, levees have long been built along the Mississippi River to protect the surrounding communities from flood events. However, beginning in the late 19th and continuing well into the 20th century, channelization of the river occurred which prevented the river from being able to partake in natural flood events that led to sediment accretion and natural elevation of the land. According to the Environmental Protection Agency, the Mississippi Bottomlands Wetland was once able to store up to 60 days' worth of floodwater, in addition to serving as a natural habitat for various forms of fish and wildlife; today, as a result of increased channelization and the construction of levees and dams, it is

estimated that these wetlands only store up to 12 days of floodwaters and experience an increase in the loss of life that is able to flourish in them (Environmental Protection Agency, 2017).

Other threats to wetlands are various forms of real estate development, which have often encroached into wetland areas due to the convenience that this option presents for humans. According to research conducted by the University of Maryland, widespread land clearing initiatives have had dire consequences for wetland ecosystems, such as increases in erosion in upland areas that lead to increased sedimentation in lowland wetlands. Such sediment accumulation changes the chemical and hydrologic makeup of wetlands in very short periods of time (Tiner and Burke, 1995).

Thus, understanding the importance of wetlands and what measures must be taken to protect and preserve them is a vital step toward incorporating environmental resilience and sustainability into city and regional planning along our coasts. Specifically, the next section of this report will examine the presence of the most common wetland types found in the Galveston Bay Watershed along the Upper Texas Coast, and their importance to sustainability for Galveston and many nearby communities located in the watershed along Galveston Bay including Houston. If policymakers and planners are able to successfully understand this, they will be able to make more lasting changes to planning and development policies and practices.

Coastal Marshes

Given its location, the Galveston Bay Watershed and Estuary System encompasses vast swaths of the Upper Texas Coast and stretches from the area just east of Matagorda Bay all the way north and eastward to the coastal areas near the Texas-Louisiana border. Much of this region is comprised of coastal marshes and prairie depressions. The former, coastal marshes, which are also known as estuarine, or tidal-fringe, wetlands have traditionally proven to be important

transitional zones between the Gulf of Mexico and land at higher elevations. Characterized by dense vegetation, plant life in these marshes has adapted water levels that fluctuate frequently with incoming and outgoing tides, as well as to salt and fresh water intrusion. The nutrients that enter the habitats with the tides are vital for the simulation of additional plant growth and the accumulation of various forms of organic matter. As was evident in other regions, the stimulation of plant growth in tidal areas is vital for the health of freshwater wetlands that serve the true purpose of the habitat to protect the coastline.

The presence of some form of vegetation allows these wetland areas to be classified as marshes. When these areas are typically characterized by a lack of vegetation, official definitions classify them as mud/salt flats, due to the abundance of muddy, moist soils that are consistently exposed to water inundation. Varying in size, these wetland ecosystems can stretch from comprising a small area to spanning more than several thousand acres. While not found on Gulf-facing beaches in the region, they can be found on the back or bay-sides of barrier islands, such as Galveston Island, extending several miles inland along various waterways that drain into the Gulf of Mexico; this specificity in their location is due in large part to their sensitivity to wave energy which has the potential to cripple the vegetation (Texas Coastal Watershed Program, 2015).

Generally, these wetland areas consist of soils ranging from clay soils to sandy soils, with clay soils being the most dominant (Texas Coastal Watershed Program, 2015). From an historical standpoint, these soils were carried to the region by moving water and deposited in the area over the last several thousand years. Of all the Texas soils, those found in the salt marshes tend to be the most organic, due in part to the decaying vegetation that provides nearby waterways with food from smaller forms of marine life, which later serve as food for fish,

mammals, and birds. Likewise, these wetland areas also serve as spawning grounds and nursery areas for various forms of marine life. Despite their highly organic composition in comparison to other soils within the State of Texas, the organic matter found in these soils is minimal when compared to those found in the Mississippi River Delta in Louisiana. In fact, soils found in Texas Estuarine Marshes typically tend to be classified as mineral soils, because of the low concentration of organic matter in the surface horizon (Texas Coastal Watershed Program, 2015).

Relating to the hydrology and vegetation of these areas, much of what grows in these wetland areas is largely determined by water levels (periodic inundation) and overall water salinity content. Despite their proximity to the coast, the salinity of these wetland areas is largely determined by the amount of freshwater that is delivered to bays and waterbodies closer to the coast by rivers flowing from the upland areas. Estuarine areas generally consist of high marshes and low marshes—with high marshes being periodically flooded by tides during coastal storms or large coastal wind events that can vary based on season, and low marshes that are regularly inundated by water (Texas Coastal Watershed Program, 2015). While saltwater inundation generally occurs in the low marshes, freshwater flooding of high marshes is generally the result of backup against high tides along many of the rivers that drain toward the coast. The relationship between hydrology and salinity comes into play when these two factors determine what types of plants are able to grow these wetland areas. Generally, both low and marshes are characterized by *spartina alterniflora*, which can be found in both low and high marshes, although it is most common in the low marshes as a result of being outcompeted by salt meadow cordgrasses in high marshes.

Prairie Depressions

Moving slightly further inland from the intertidal zone, the coastal prairie is also characterized by unique wetland types, including the prairie pothole wetlands. The Gulf Coastal Plain of the Upper Texas Coast is characterized by a flat, historically grassy landscape that is intersected by several bayous and rivers that deposit themselves into the Gulf of Mexico. Pothole wetlands can most easily be described as shallow ponds, or freshwater depressions, which are much smaller and more defined than marshes (Texas A&M AgriLife Extension, n.d.). Sources estimate that they once covered nearly 30% of the Texas Coastal Plain, stretching from Beaumont in Southeast Texas southward toward the Rio Grande Valley. With the rapid expansion of cities and increases in urbanization that occurred around them mid-twentieth century, many of these wetland areas were destroyed by land development.

Geologically, prairie pothole wetlands are most commonly found on the Upper Texas Coast (Southeast Texas) along the Lissie and Beaumont Geological Formations. Many of them are the remnants of rivers that once spanned and inundated wide swaths of the coastal prairie. In the past, these wetlands covered between 25% and 30% of the Texas Coastal Prairie, and despite the fact that they regularly dry out, they maintain their hydric wetland soils (Jordan Cooley, 2015). Speaking to their relative importance for the region, prairie pothole wetlands are often responsible for the recharge of groundwater supplies, allowing water to infiltrate the ground surface over time. Additionally, their natural bowl-shape allows them to store floodwaters over time and protect low-lying areas further downstream (American Rivers Foundation, 2017).

Information gathered from research conducted by Texas A&M University suggests that these wetland ecosystems provide more water for Galveston Bay and other surrounding bays than the United States Government cares to admit, as explained further below (Tresaugue, 2011).

These depression wetlands have ample surface water pathways that connect them to each other and surrounding water bodies. In fact, detailed results from a 2011 study run contrary to the traditional conceptions that paint these wetlands as isolated bodies of water, leading to the need for changes in the ways in which these wetlands are regulated by the federal government. While prairie pothole wetlands have long been considered isolated wetlands because of their close proximity to more upland areas away from the immediate shoreline, evidence reveals that subsurface pathways link these wetland areas with nearby waterways. Specifically in the case of the Upper Texas Coast, various interconnected sloughs and seasonally wet drainage paths connect these wetland bodies to larger bodies of water, such as the Galveston Bay System (Wilcox et. al, 2011).

In analyzing runoff over a 45-month period between area watersheds containing soil of the Verland Silty Clay Loam Typology and Armand Bayou, a stream along the Beaumont Geologic Formation just south of Houston that deposits into the Galveston Bay system, research indicates that the watershed soils were "significantly wetter" than what is typical for those soils of the Verland series—revealing the presence of subtle drainage features and a strong surface-water connection in the Armand Bayou Complex. Theorists postulate that these results could potentially be unique to the pothole wetlands of the Texas Gulf Coastal Plain, because the majority of these wetlands tend to be connected by intermittently flowing channels that are covered with dense wetland vegetation and wetland soils. When the storage capacity of these wetland areas is exceeded, they discharge excess water downslope, sending a significant amount of runoff into the Galveston Bay System (Wilcox et. al, 2011).

The results of the aforementioned study run counter to previous studies conducted by the U.S. Army Corps of Engineers, furthering the idea that these wetlands were isolated from the

waters of the Galveston Bay System. In fact, per a 2001 Supreme Court ruling, the federal government —of which the Corps of Engineers is an administrative arm—was declared not responsible for claiming jurisdiction and maintenance over wetland bodies that "are not connected to a navigable bay or waterway," thereby excluding those of this particular type from protection (Tresaugue, 2011). The same study indicated that continuing to classify these wetlands in isolation has proven to be detrimental to these areas, because they have not been afforded the necessary protection and regulation to further enable them to service surrounding ecosystems. In fact, research indicates that between 2000 and 2011, the Upper Texas Coast—especially in and around Harris County—has lost thousands of acres of pothole wetlands as a result of development. This is only expected to worsen as the Houston Metropolitan Region stands to grow significantly over the course of the next half-century, putting as much as 190,000 acres of coastal prairie (pothole) wetlands at risk.

In the aftermath of the widespread flooding and devastation caused by Hurricane Harvey in August 2017, the nature and importance of coastal prairie wetlands has resurfaced in their capacity to retain surface water in addition to providing a connection to larger bodies of water. Perhaps most importantly, these wetlands serve as natural detention basins for storm water that would otherwise cause flooding hazards while also cleansing and filtering surface water of contaminants. While their abilities to capture water are indirect, they play a vital role in maintaining water quality and flood control (Jacob, 2015).

Bottomland Hardwoods

Bottomland Hardwoods are quite common along the watersheds that empty into the Gulf of Mexico along the Upper Texas Coast. In fact, several of these wetland areas include the Big Thicket National Preserve, Village Creek State Park, and the Trinity River National Wildlife

Refuge to name a few (Texas Coastal Watershed Program, 2015). Typologically speaking, bottomland hardwoods are essentially riverine forested wetlands that can be found along the floodplains of rivers and streams in the region (Texas Coastal Watershed Program, 2015). The broad floodplains that are associated with the many rivers in the region support these riverine forests, which are quite extensive in size.

The Bottomland Hardwood wetland consists of alluvial soils, or those that are constantly renewed by the intermittent flow of water throughout these ecosystem areas. Similar to the Bottomland Hardwoods that are found in the Mississippi River Delta, these forests feature a natural hydrologic regime of alternating wet and dry periods that are the result of seasonal flooding. Furthermore, the alluvial nature of the soils in this region make for a productive habitat, because of the richness of dissolved organic matter and nutrients that pass through the area during periodic flooding events. Hydrologically, these wetland areas receive the majority of their water from overbank river flooding, which can vary from several weeks to several months in terms of the amount of time spent inundated (Texas A&M AgriLife Extension, n.d.).

Similar to swamps, which are areas that are submerged for extended periods of time, bottomland hardwood forests typically feature vegetation that has adapted to alluvial soils and been submerged in water for long periods of time. Species that are common to this biome include *gum*, *bald cypress*, and *oak* trees. Indicating their unique adaptations to such environments, these plant species have developed buttresses, or knees, in the case of the bald cypress trees, and fluted trunks and flared bases to assist with providing structural stability in unstable substrates—all of which sustain them during periods of high-water cover (Texas A&M AgriLife Extension, n.d.). Bottomland Hardwood Forests are also the sites of ample biodiversity—not only in terms of

plants, but also in terms of the wildlife that can be found, which includes ample types of birds and marine life.

Steps toward Sustainability

The aforementioned research implies is that planning for environmental sustainability in the City of Galveston extends beyond the city itself and is largely tied to ongoing regional environmental sustainability efforts. The overall health of the Galveston Bay Watershed and its wetland ecosystems have a major impact on Galveston's ability to remain environmentally resilient to natural shocks. Research reveals that anthropogenic changes to the watershed's landscape have largely contributed to the destruction of existing natural mechanisms to mitigate the impact of hazards common to coastal communities. Changes to policies surrounding development could do a great deal to make development on Galveston Island and throughout the Galveston Bay Watershed more sustainable. At present, development practices do great harm to the natural ecosystem and are not sustainable, as they only exacerbate existing risks by depleting the area of natural protection.

Given the rapid deterioration of wetland areas that have provided valuable benefits for nearby bay and watershed systems in Southeast Texas, one could draw lessons from the many ways in which a region stands to benefit by maintaining these ecosystems. For too long, there was little to no discussion of the value of wetland ecosystems to the Upper Texas Coast, because there was largely not enough information or understanding to adequately regulate their maintenance. Thus, it became increasingly easy for developers to nearly eradicate these ecosystems for financial gain. Furthermore, because local municipalities were naturally concerned with economic growth and development, they undertook little effort to enact policies

that would protect wetland areas and require developers to pay environmental mitigation fees for any destruction caused to these ecosystems.

Source: JONES|CARTER Engineering

Throughout Southeast Texas, discussion and public interest in the values of these ecosystem areas to the larger bay systems only surfaced in recent years following catastrophic flooding events, including Hurricane Ike in 2008 and Hurricane Harvey in 2017. Hurricane Ike was a historically large storm surge event for the Galveston Island, the larger Houston Area, and communities further eastward extending into Louisiana. In the years immediately following the storm, officials at Texas A&M University proposed the Ike Dike Project to serve as a storm surge barrier for the communities surrounding Galveston Bay. At the time, the proposed dike system would have extended the initial protection offered to Galveston by the Galveston Seawall to the entire shoreline of Galveston Island, in addition to a 17-foot high structure strategically positioned to protect the bayside of Galveston and the Island from high tides and storm surges (Rice, 2014).

The project also called for large floodgates to be placed at the entrances to the Houston, Galveston, and Texas City Ship Channels. Nevertheless, once recovery was well underway for most of the Houston-The Woodlands-Sugar Land Metropolitan Area, calls to implement disaster mitigation strategies faded. Instead, to Galveston and the entire region's detriment, recovery efforts were largely focused on rehabilitating the region to its status as was before Hurricane Ike—not to a more resilient one (Rice, 2014). Following the devastation caused by Hurricane Harvey in 2017, Congress allotted nearly $15 million in relief funding for the State of Texas, but the funding could not be used for the construction of a barrier; rather, it could only be used toward rehabilitating the areas that flooded as a result of Hurricane Harvey (Harvey Rice, 2014).

Local and federal responses to these catastrophic events reveal three important points for consideration when discussing resilience throughout the region. First, implementing strategies to make the area more resilient must be done in the immediate aftermath of a major catastrophic event. It is during this time that public awareness and willingness to listen to proposed improvements are heightened. As is visible with the Ike Dike Project, officials waited too long to take action, and only in 2018 had money actually been approved by the United States Army Corps of Engineers for the construction of a barrier structure (Nick Powell, 2018). Second, the portion of the Upper Texas Coast including Galveston has become increasingly vulnerable to changes in sea level and catastrophic cyclone events, because of a lack of resiliency over the last century. Finally, when comparing current measures toward resilience in this sub-region, one cannot help postulate that local officials are severely behind in their planning, especially when comparing these efforts to what has been done in Greater New Orleans and the Netherlands. Evidence still reveals that there is a lack of understanding on how to improve the region's resilience.

While local officials have discussed plans to mitigate flooding through the erection of barriers, only two entities, both of them research institutions—Rice University and Texas A&M University—have actively called for the complete restoration of wetland areas throughout the region and the conservation of land to protect it from development that would decrease the natural abilities of wetland areas to provide coastal protection. The aforementioned illustrates a complete lack of understanding among the general public and policymakers of the benefits of wetland areas to the region and the importance of developing policy and planning initiatives that incorporate them into the increasingly urban fabric of various cities in the region, instead of merely eradicating them. In order to foster resilience infrastructure, local officials will have to devote time and resources toward educating stakeholders on the benefits of resilient planning and the ways in which local wetland areas impact the larger bay-area watersheds, as well as get them on board politically, financially, and socially to support devising new plans (including for land uses) that build for a more resilient region.

Analysis of Resilience and Sustainability in Galveston

The existing Comprehensive Plan for the City of Galveston outlines several long-range goals and policies that will affect the city's competitiveness, livability, and sustainability. According to the plan, the document's goal is to serve as an important guide for local decision-makers and stakeholders. Several goals, objectives, and strategies to foster long-term growth and development for the city are outlined in the plan, especially those affecting:

- the quality and character of the island's commercial and employment districts, industrial centers, and key corridors such as Broadway Boulevard, Seawall Boulevard, and 61st Street;
- the conservation and improvement of neighborhoods throughout the city, including the rebuilding and renewal of neighborhoods that suffered extensive damage from Hurricane Ike;
- the protection and management of sensitive natural and cultural resources; and
- investments in the city's transportation network, community facilities, utilities, and other support systems.

Planning areas covered by the city's comprehensive plan include elements on housing and neighborhoods, economic development, land use and community character, historic preservation, natural resources, transportation, infrastructure, disaster planning, and the city's people – several of which will be evaluated throughout this analysis.

Upon first glance, it appears that the city has begun earnestly devising several methods through which the city can grow to become more sustainable and resilient. It is important to note that Galveston adopted its existing comprehensive plan in 2011, following the shocks of Hurricane Ike in 2008 and the Great Recession of 2008. Ample community input was gathered

during the various phases of devising the city's comprehensive plan. The city also incorporated ample opportunities for public-private partnerships toward broad-based planning to improve and foster sustainable living conditions on the island for residents, as well as economic conditions on the island for both residents and business—all in efforts to make the city more resilient to both predicted and unexpected changes over the next several decades.

One positive observation about the plan is that it attempts to strategically interlink various sections of the plan to one another, indicating the comprehensive nature of planning that the city has put forward toward fostering resilience and sustainability. The existing plan was an update to an earlier plan that had been finalized in 2001; since that time, the island city has made considerable progress toward furthering goals. However, the economic and demographic characteristics of the city have changed through population decline, due in part to a lack of housing affordability; a stagnant economy in comparison to the rest of the region; and Hurricane Ike. Thus, for the purposes of this analysis, we can expect that the city's comprehensive plan will embody several examples of planning that incorporate resilience and sustainability.

Environmental Sustainability Analysis

The City of Galveston Comprehensive Plan attempts to address environmental sustainability through many of the objectives set forth in the comprehensive plan. The Natural Resources Element presents ample strategies to allow officials to attempt to balance the general interests of the public by encouraging investment and protecting sensitive and unique natural resources. This element of the plan focuses specifically on water quality, preservation of open space from encroaching development, and protection of many of the natural features of Galveston Island that protect the city such as dunes and wetlands. Additionally, this section of the plan makes strides to implement plans to restore local wetlands and to regulate their

protection, in addition to limiting the harmful effects that human impact and development can have on such habitats as has been called for by scientific researchers in the region.

The principal goal of the Natural Resources Element of the plan is to protect and preserve the sensitive natural resources of Galveston Island, the Bay Estuary System, and the Gulf of Mexico. In doing so, maintenance and improvement of water quality in the Galveston Bay Estuary System and a minimization of risk to human health together comprise the plan's primary objective. The plan acknowledges what history confirms—the health of Galveston Bay is largely linked to water that is discharged from the cities surrounding lower Galveston Bay and West Bay, which includes the City of Galveston. However, the health of the Bay is also linked to water quality and discharges from areas further upstream but still very much a part of the Bay Estuary System, especially in nearby Houston.

Thus, the plan cites that a major priority moving forward must be the reduction of non-point contamination of bay tributaries and near-shore waters. Non-point contamination is the process of water contamination that results from environmental elements that are widely distributed or pervasive in an ecosystem. Such contamination occurs in water bodies when rainfall transports land surface-based contaminants into adjacent waterways, as well as when water quality is compromised by pollutants that stem from water penetrating through the soil, such as wastewater in a septic system. According to the plan, failing septic systems have been identified as a main point of water quality contamination. Consequently, the city notes the need to place a priority on identifying strategies to implement policies and ordinances, as well as to invest in local infrastructure, in order to improve water quality on the island and in Galveston Bay. In addition to non-point contamination, water quality is disproportionately affected by the waste discharges from boats in many of the city's marinas.

As a second objective, the Natural Resources Element of the plan identifies the need to strengthen regulations that were designed to protect and restore the many dune systems on the island. Citing the important role that dunes play in stabilizing the shoreline along Galveston Island, the plan notes that these natural features have been preserved in the years following Hurricane Ike through compliance with the Texas Open Beaches Act and the Dune Protection Act. Likewise, policies enacted at the state level have called for the adoption of new regulations that encourage communities along the coast to develop erosion response plans that provide blueprints for coastal restoration under the Coastal Erosion Planning and Response Act Program.

Specifically, the plan acknowledges that wetland losses on Galveston Island have been the result of human-induced subsidence in addition to sea level rise, erosion, and dredge-and-fill activities. Furthermore, the city has the responsibility to make it a priority to protect and preserve these habitats through expansion of staff personnel and capabilities, effective enforcement of existing wetland regulations, and the institution of a formal process of land conservation to protect areas that are adjacent to wetlands. Furthermore, at the time of the draft of the Comprehensive Plan, the city was considering adopting a wetland ordinance that would protect both tidal and non-tidal wetlands from disturbance and filter storm water as it entered into wetland systems.

Existing zoning regulations in the City of Galveston, however, have not done a good job at addressing the environmental issues that pertain to the city's geographic location on a barrier island. Furthermore, despite nods toward protecting and restoring wetland areas and other natural features that make the island and the city more resilient, some of the goals of the city's Infrastructure Element appear to contradict those established in the Natural Element through the adoption of an Erosion Response Plan. The city commits to reviewing rules that affect

construction along many of its beaches, in addition to conducting studies that shed light on natural erosion rates and conditions pertaining to the island's dunes, and development standards to enhance the condition of the island's wetland systems.

Additionally, the plan also acknowledges the regulatory role of the United States Army Core of Engineers and the United States Environmental Protection Agency in issuing permits for wetland mitigation, and establishes a goal of maintaining active participation in the review and permitting processes. Such acknowledgments are not only indicative of the city's intention to do better in protecting and restoring natural ecosystems, but they are also indicative of the plan's efforts to implement intergovernmental coordination toward building a more resilient city.

Through the creation of a plan to protect open space on the island, Galveston also seeks to implement several initiatives to create a network of permanently open space, such as the East End Lagoon, which is a 686-acre preserve of land located at the easternmost tip of the island and at the mouth of Galveston Bay. However, the plan also notes that the embrace of open-space creation will only be possible if conservation development for larger tracts of land is actively promoted by the city and if developers agree—which could be easier said than done. Nevertheless, if the plan succeeds in incorporating open space initiatives into various existing plans and programs, then there is the likelihood that open space preservation will become more feasible in the City of Galveston.

One of the most important objectives set forth in the Natural Resources Element is that of making the general public aware of protecting the island's natural resources, which then translates to local efforts to make the island more sustainable and resilient. The plan notes the necessity of residents understanding the importance of the natural environment, in addition to improving coordination between various public and private entities for management of natural

areas. In order to encourage a sustainable ecosystem, it is important that all stakeholders understand their roles toward making the city planning practices more sustainable and resilient. As evident in the case of New Orleans, beyond policies set in motion by agencies, one of the most effective ways to influence change is through the political process, which involves active participation by and on behalf of the larger citizen body.

Environmental sustainability cannot be achieved without addressing infrastructure. The Infrastructure Element of the plan addresses the ways in which Galveston will be able to provide resilient and adequate infrastructure that is closely linked with the hazard mitigation plan to protect the city's infrastructure, in addition to the health and welfare of city residents by, for example, improving the function and dependability of the storm drainage system. This includes exploration of new methods to properly manage storm water run-off, which could directly lead to the minimization of local flooding during periodic storm events, improvement of surface water quality, and the incorporation of practices that comply with federal and state assistance. Similar to what was accomplished in New Orleans, the plan recommends that Galveston raise several of its properties through the use of fill materials, and successfully mitigate the potential for raised properties to negatively affect surrounding parcels.

Also similar to New Orleans, the plan encourages residents to establish rain gardens, or landscaped areas that can hold water until it is absorbed into the ground and rainwater harvesting system. It also encourages the resilience of utilities, infrastructure, and public facilities including water lines, sewer lines, gas line, electricity and telecommunication services, as evident in an existing hazard mitigation plan. However, the reality is that the city should explore non-structural mitigation strategies that can be remediated and easily explored. Such non-structural ideas represent an alternative to the Ike Dike.

In addressing infrastructure, the plan outlines the existing land use and community character element in a way that provides for a balance of land uses and associated regulations to enhance quality of life and character of the city. The plan notes that in the urbanized core, there was an imperative to keep road and other forms of infrastructure behind the seawall. Thus, this section of the plan focuses on stabilization and revitalization of residential, commercial, and industrial acres in addition to blight removal and the cultivation of new community activities. While the East End of the city near the urbanized core is largely built out, the easternmost and westernmost ends of the city contain large tracts of land that have yet to be developed despite significant actions to ensure the long-term stability of older neighborhoods and insert new neighborhoods and communities.

While establishing the promotion of revitalization, enhancement, and appropriate intensity and mix of uses in the Central Business District as a second objective, the plan notes that commercial and mixed-use development in the Central Business District, as well as along major corridors, should be guided by clear goals and objectives, market responsive plans, capital investment strategies, and development standards and guidelines that promote quality private investment. As the plan shifts from explicitly discussing environmental sustainability, it notably focuses on land use changes that will enhance business and economic development, especially through beautification, while rarely making mention of land use changes that pertain to environmental sustainability. One of the goals of this specific objective is to promote the development of an area known as the East End Flats for mixed-use purposes. Geographically, the East End Flats is an area consisting of 600-acres of land that the Army Corps of Engineers utilizes as a depository for dredge material. Located south of the East End Lagoon and sitting at the mouth of the bay and at the easternmost point on the island, the area is considered to be one

of the last and best undeveloped tracts of land on the east end of the island (Wilder, 2008). To promote a mixed-use development to address housing needs on the island in an area that maintains proximity to the educational facilities, industrial jobs, and Central Business District core, such goals represent an opportunity to expand the tax base. However, it is important to note that the very act of developing such a large expanse of land is contradictory to the environmental plan of integrating and preserving open space.

Likewise such a plan also comes with proposals to develop neighborhoods and village centers on the West End of Galveston Island. These proposals contradict the recommendations of scientists to avoid, if at all possible, any development on the West End. According to researchers at the Rice University School of Architecture and the Shell Center for Sustainable Development, even if such development is mixed-use, likely to minimize the number of auto-trips to the East End for commercial and other purposes, and minimal in the number of impacts to scenic and natural resources, no development should be placed on the side of the island that faces some of the highest erosion rates and where environmental conservation should be the principal focus (Hight et. al, 2010).

Economic Sustainability Analysis

While the Land Use and Community Character element of the plan fails in many ways at touching on the incorporation of environmental sustainability, much of what is presented does speak to the short-term goals of the city toward making economic progress. The Comprehensive Plan seeks to promote "private investment in the City's key corridors and districts" through various elements that include "the City's historic strengths in tourism, ports, and higher education" (Galveston Comprehensive Plan, 2011). Also, he plan correctly acknowledges that prior to Hurricane Ike, much of Galveston's inner-urban core experienced massive disinvestment

as the city's economy decline and many long-time residents moved to other parts of the Houston metropolitan area. Such disinvestment led to a deterioration of urban infrastructure that left the city vulnerable by the time that Hurricane Ike made landfall. Noting that "since 2001, the City has increased funding and focused its efforts in infrastructure improvements to reverse the decades long trend of neglect," funding of such improvements are slated to come through improved implementation of the City's Capital Improvement Plan, in addition to disaster recovery funding received from the federal government following Ike (Galveston Comprehensive Plan, 2011).

As an initial goal, the plan strives to create and retain jobs, expand the city's economy, and enhance the quality of life for residents. A key strategy to achieve this is through urban infrastructure reinvestment, especially through the enhancement of corridor projects for the benefit of middle-income residents. Another economic objective that is linked to land use and community character is the acknowledgment that the city's older and historic neighborhoods are its greatest assets and that the highest priority should be dedicated toward protecting the city's historic housing stock. With their historic charm, such areas feature character, quality, and diverse housing types—all of which could add to local aesthetic value and attract tourists. Also, walkable streets and mixed-use buildings create high livability for the neighborhoods near the urban core, and thus, contribute to enhancing residential quality of life.

The City of Galveston is undoubtedly placing a priority on the incorporation of more mixed uses through infill development. As the plan notes, "…infill projects represent the best and most immediate opportunities to introduce additional middle-income housing units" (Galveston Comprehensive Plan, 2011). As the city strives to attract a variety of investors, mixed-use districts stand to appeal to a variety of stakeholders. Furthermore, the plan notes that

the city should "take the initiative in demonstrating the feasibility of middle-income housing on the Island, and provide incentives and catalysts for development through actions such as investments in infrastructure and direct developer solicitation and selection" (Galveston Comprehensive Plan, 2011). In order to maintain the attraction of such neighborhoods, the comprehensive plan notes needed reinvestment through development to enhance its competitive edge with other cities in the region. Citing that the Capital Improvement Plan has increased infrastructure investment since its implementation in 2001, in addition to ample disaster recovery funds received since Hurricane Ike in 2008, the 2010s saw Galveston much more active than it had been in previous years. Nevertheless, declines in assistance from the Federal Government require the city to determine its own best practices through the diversification of city revenues and maintenance of a balanced city budget.

In addition to increasing the funding toward the Capital Improvement Plan, the comprehensive plan calls for the ongoing revitalization of the Central Business District and other mixed-use corridors, as well as the establishment of the Galveston Revitalization Authority for the long-term redevelopment of several of the city's neighborhoods, commercial corridors, and the Port of Galveston. With reinvestment, the Revitalization Authority will have the ability to support other forms of indirect economic development, including housing, commercial, and business opportunities through public-private partnerships and direct funding.

Regarding sustainable economic development, Galveston seeks to be a leader in such growth by finding ample ways to attract "green" industry and businesses to the city, developing incentives for more energy-efficient and sustainable buildings for new business development, encouraging businesses to become more resilient and adopt sustainability practices, and preparing studies to illustrate the importance of private investment and relocation. Growing

traditional strengths, including tourism, the port, industrial development, and higher education appear to be key objectives toward economic sustainability. It appears that in framing the comprehensive plan, city officials and stakeholders view it as most feasible to strengthen and diversify the competitive strength of traditional mainstays of the local economy. With accrued investment and capital attraction, the city will be able to transition toward developing new strengths that allow it to further capitalize on its location, as well as other human and institutional resources.

Achieving such objectives would entail the facilitation of the development and enhancement of the Port of Galveston to accommodate more cruise ships and Galveston's status as a port of call—which has in fact happened—as well as the development of further eco-tourism initiatives, such as the East End Lagoon Nature Preserve. At the time of the plan's drafting, the framers saw the continued expansion of port facilities on both Galveston and nearby Pelican Islands, which have the possibility to increase maritime and industrial activities. While the plan purports to further these goals, the city still places a priority on continuing the development of industrial businesses that support the Port and other industries, such as off-shore industries, without minimizing other goals of the city.

Galveston seeks to position itself as a city that actively supports the development of new businesses and industries at strategic sites through infrastructure funding initiatives. As a result, the city will focus infrastructure investments in areas that are close to sites and locations that are disinvested and where private investment will likely take place. Additionally, the city will also seek to improve the ways in which development approval and permitting are granted to new developers by expediting the application processes and ensuring that the city remains committed

to the facilitation of continued growth, even though this contradicts what was presented in the city's environmental sustainability objectives and goals.

As mentioned previously, what is questionable about the city's economic development strategy is that by strategically focusing on attracting middle income workers and developing infrastructure for such groups, the plan conveniently ignores the impoverished residents that live on the island. In 2010, the City of Galveston had a poverty rate of 22.6%, which was significantly higher than the state average of 14.7%. Given such statistics, it is puzzling that there is little mention of poverty alleviation on the island and the development of infrastructure to alleviate poverty (U.S. Census Bureau, 2010). Economically, the plan identifies the city's objective to promote development of a quality workforce that will meet the needs of employees. Identifying Galvestonians as the city's most prized asset, the plan establishes that the availability of a trained, motivated workforce with appropriate technical skills is a key factor in investment and locational decisions by private industry. Still, the plan does not allude to whether the city will train its existing workforce to acquire the skills needed to attract needed investment or essentially import a trained, motivated workforce from elsewhere.

As a means of stimulating the economy however, the plan does call for the various forms of specialized tourism that would allow the city to capitalize on its natural resources and topography. Such economic generators include eco-tourism, heritage and cultural tourism, as well as recreational opportunities along the city's beaches and Galveston Bay. Such measures have already been achieved since the plan's adoption with the development of the East End Lagoon and Nature Preserve—which allows residents and tourists alike to take advantage of the natural landscape while also protecting natural resources. Furthermore, by securing funding through the Capital Improvement Program, the city will utilize natural resources to generate

more tourism. Similarly, Galveston can further capitalize on its historic districts by implementing goals related to heritage tourism and supporting continued historic preservation through revitalization.

On the same note, the plan identifies the need to facilitate the development of workforce and middle-income housing—indicating that the ability of the city grow economically is hampered by the lack of affordable, competitive workforce and middle-income housing. Such housing demands have strained the city's existing workforce and forced many to relocate from the city to suburbs on the mainland. While Galveston saw an increase in the number of second-home and long-term rental properties in the years leading up to 2011, such growth and changes raised property values, making it more difficult for full-time residents to pursue quality housing options. Galveston's expansion of middle-income housing proved to be an economic development priority. According to the comprehensive plan, in order to ensure the availability of workforce and middle-income family housing near jobs and services in the urban core, the City of Galveston will have to encourage infill development on individual lots and in small subdivisions—in addition to promoting the development of new market-rate, high-density urban housing and identifying locations such as North Broadway and the East End Flats as places where a wide range of housing can be provided through redevelopment and construction.

Sustainability in Housing

As outlined in the Economic Development Initiative of the Plan, the city had objectives of coordinating with the Galveston Economic Development Partnership and other developers to minimize and remove regulatory and other types of impediments to middle income housing developments. Likewise, the city had plans to continue to support and encourage housing developments on the underdeveloped east and west portions of the island, in addition to the

expansion of housing choices for renters, elderly persons, and low to moderate income, and middle-income households through infill development and improvement of the city's existing housing stock.

Establishing that 75% of the city's housing stock was damaged through wind or flooding during Hurricane Ike, the principal Housing and Neighborhoods Goal for the city is to expand the availability of quality housing in such a way that it meets the needs of a diverse population, in addition to building strong neighborhoods to enhance community character. It is clear that reinvestment in the urban housing stock would be crucial to promoting the city's sustainability goals. Interestingly, the plan notes that much of the existing housing stock on the island is already sustainable, because of its age. Given that many of the city's houses were built before electricity and air conditioning were commonplace, the housing stock is largely designed to take advantage of natural light and harness localized weather patterns for cooling. Thus in promoting sustainability of the existing housing stock, the city should also provide programs that improve energy efficiency in existing housing structures, as well as new ones, and incorporating green building standards into structural designs.

One of the first objectives of the housing goal is to expand middle-income housing. As per the plan, "nearly 3 out of 5 households in the City of Galveston were renting in 2010" (Galveston Comprehensive Plan, 2011). The high concentration of renters in the city is a major impediment to the maintenance of strong, stable neighborhoods. However, the rental concentrations are high, because of a lack of affordability. Interestingly, one of the housing objectives of the plan is to "encourage the development of housing suited to the unique character of Galveston Island, outside the urban core" (Galveston Comprehensive Plan, 2011). This would expand the supply of middle-income housing in a way that is more cost-efficient and allows

developers to take advantage of additional land area that cannot be found in the city's older, denser neighborhoods. However, unless such development is done in ways that retains open space and preserves natural resources, additional development could be an ecological disaster for the island and the city as a whole. Such development objectives allude to the efforts of the city to capitalize on the city's geography, having access to beaches and the Gulf of Mexico, which present great opportunities to expand the community's tax base and its supply of quality housing. Nevertheless, the plan does note that development on the sought-after West End must be permitted where the City "has the ability to provide for public safety and property protection for residents" (Galveston Comprehensive Plan, 2011). Likewise, such development must be consistent with the conservation of natural features. Permission of such development—albeit with restrictions—indicates the city's need for revenue generating development, as recent environmental feasibility analyses have strongly recommended against the permission of development on the city's West End.

Nevertheless, the city has made it a priority to encourage the introduction of new single-family houses on vacant lots in many of the older neighborhoods—infill development—as a means of promoting middle-income housing in existing neighborhoods and future mixed-use districts and neighborhoods centers. The plan's reliance on mixed-use districts is largely based on their appeal to broad segments of the housing market by spurring more development in locations that will support the growth of office and institutional employment in the Central Business District. As a means of supporting such housing development, the city outlines plans to create incentives to promote housing infill, reinvestment, and homeownership, such as financial incentives for conversions of rental property to single-family-owned homes in addition to tax

abatement for homeowners and the provision of direct financial assistance to first-time homeowners.

As indicated in the earlier discussion of summary findings on environmental research conducted in the Houston-Galveston area, development on the westernmost area of Galveston Island should be limited, especially in discussing housing. Developing on Galveston's West End would yield structures that are not protected by the Galveston Seawall, in addition to harming the natural environment. As put forth by experts from Rice University, such development patterns are no sustainable, because the risk of property loss becomes increasingly high.

Planning officials cannot deny the aforementioned facts, as the plan also briefly asserts, as part of its objective of encouraging housing development suited to the unique character of the island. That housing development on the West End should be permitted where the City has the ability to provide for public safety and protection of property for city residents. Likewise, development must be consistent with the protection of dunes, wetlands, and scenic open space—which means that it should be limited. Despite the potential for open space and conservation on the area known as the East End Flats and its location at the mouth of Galveston Bay on the easternmost edge of the island, it does appear to be more feasible for development than the island's West End, given that it is protected by the Galveston Seawall and provides ample proximity to the city's industrial core—most notably the Port of Galveston and Pelican Island—and the Central Business District. Such proximity provides an opportunity to expand the supply of middle-income housing to accommodate those located on the urban core of the island.

In 2011, homeownership rates in the city were far below the national averages, making it an important priority to reverse the traditional imbalance of renters to homeowners in the city. The plan outlines that the City of Galveston's priority to complement the efforts of the Galveston

Housing Authority and other non-profit organizations to enable qualified low-moderate income families to purchase their own homes. By the same token, the city's priority on encouraging reinvestment into local communities includes an aggressive and strategically targeted code enforcement effort to remove blight, protect historic structures, and reverse trends in disinvestment. In essence, the city plans to actively enforce code standards for structures that are habitable while removing structures that are classified as dilapidated.

The city's objective to expand housing for choices for low to moderate and workforce income households to strengthen neighborhoods is essentially backed by plans to harness federal and state funding sources, including those provided following disasters, such as Ike, while also pledging to partner with non-profit housing providers including the Galveston Housing Authority and the Community Housing Development Organizations to create strategies that promote independence and community pride. At the time, the City of Galveston has a Homebuyer Assistance Program that was able to provide up to $14,500 in HOME funds per homebuyer for assistance toward making a down payment on a home, as well as closing costs.

In implementing new housing assistance programs to ensure workforce housing, the city indicates that assistance programs could target civil servants and key service providers to reduce the number of people who work on the island, but live in other parts of the metropolitan area. While the comprehensive plan states that incentives should be established to encourage business relocations to the area, to increase the employment of residents on Galveston Island, the plan makes no mention of how this can be done in such a way that working-class people can continue to afford to live there. Interestingly, and similar to what was done in New Orleans, the plan recommends the possible adoption of inclusionary housing ordinances for further development to provide an increased supply of workforce and affordable housing units. While such ordinances

would be effective locally, they are prohibited for homeownership housing by law in the State of Texas.

As evident in New Orleans, the creation of sustainable and affordable housing is undeniably dependent upon the political processes and the direct advocacy of citizens. The plan identifies the city's desire to create new organizational structures to mobilize city housing efforts and to create expanded community housing partnerships through the Galveston Housing Authority, private housing investors, and charitable organizations. It also states the critical need for the city to expand its capabilities to promote reinvestment, enforce codes, and invest in amenities. Similarly, the city will have to expand its capabilities to coordinate across governmental sectors to ensure that funding and resources are in place to support the objectives and goals outlined in the plan. While the plan places importance on listening to the citizen body and improving the quality of life for citizens, this should be one of the most important priorities for the City of Galveston in achieving sustainability from environmental and housing perspectives.

The plan asserts that the City of Galveston should establish a Housing Director position to coordinate housing entities and implement a tracking system for all housing projects in the city. However, it is also important that the city examine its existing departmental and budgeting structure to enforce the availability of tangible items to achieve the outcomes of the goals. This includes the expansion and consolidation of departments that handle code enforcement, public works, parks and recreation, legal, police, and development permitting—which could be challenging for a small city. Also included in this is the proposed expansion of a rental housing licensing program that would provide for a reliable inventory of the city's rental units and improvement of substandard properties. The city should understand the composition of its

housing and neighborhood structure—notably determining who lives in what neighborhood and what issues affect them. Also, given that the plan identifies the exodus of former Galveston residents from the island as a result of the lack of affordability, the City of Galveston should implement methods to determine what existing pressures are on residents in preventing them from staying in the city.

Analyzing Housing Sustainability Outside of the Comprehensive Plan

Despite what the Comprehensive Plan details, actions taken by Galveston officials in the near-decade following Hurricane Ike indicate that the City is very hesitant to bring back housing options to support low-income residents. Such an assertion is no more evident in the city's decision to eradicate several public housing units following Hurricane Ike. Following the storm, the recovery process for the city began as a slow one, possibly due in part to bureaucratic processes and the economic recession of 2008. However, housing recovery on the island was an even slower one—a largely complex process that had a disproportionate impact on the city's poorest and most vulnerable residents.

Following Hurricane Ike, the United States Government awarded $3.1 billion to the State of Texas for recovery efforts—over 40% of which was for infrastructure and economic development initiatives. According to the Texas Observer, while most of the damage resulting from the hurricane occurred in urban or semi-urban areas, then-governor of the State of Texas placed Rick Perry placed the Texas Department of Rural Affairs (TDRA) in charge of infrastructure recovery—making the distribution of funds to hurricane-ravaged residents a complex process due to the agency's primary function of funneling federal grants to rural communities (Wilder, 2013; Wilder, 2011). Adding insult to injury, the TDRA hired HNTB, an environmental engineering and planning firm, to oversee the redevelopment of infrastructure

following the storm, which ultimately proved to be costly since it drained the agency of funds for administrative costs. Opponents of the move criticized the Office of Governor Rick Perry for dodging responsibility by placing the TDRA in charge of recovery efforts, because this essentially absolved the governor from having to make decision on recovery (Wilder, 2011). This decision also had the effect of shifting monetary distributions away from the Houston-Galveston area to East Texas, which suffered much less damage from Ike. It also resulted in low- and moderate-income residents not receiving as much assistance from the government as expensive infrastructure projects—many of which were favored by local politicians.

During this time, several lawsuits were brought against the Texas Department of Rural Affairs, which based the distribution of funds on weather data, instead of on-the-ground damage assessments performed by FEMA inspectors. As a result, accurate information was never truly gathered to determine where the most damage occurred. For example, damage to an empty field was essentially evaluated the same as damage to actual structures within a community. In 2009, Texas Appleseed and the Texas Low-Income Housing Information Service filed complaints with the U.S. Department of Housing and Urban Development (HUD) alleging violations on the part of the State of Texas of the Fair Housing Act. HUD agreed with the complaints and forced the State of Texas to prioritize housing for poor and middle-class victims of the storm, thus shifting recovery funds from rural East Texas back to the Houston Metropolitan Area, in addition to changing the focus of the funds from infrastructure to housing.

Unsurprisingly, housing recovery proved to be equally as slow as infrastructure recovery. While recovery was initially entrusted to the Texas Department of Housing and Community Affairs, it was later transferred to the Texas General Land Office in 2011. By this time, three years after the hurricane, the State of Texas had only spent less than 3% of the $1.7 billion that

had been earmarked for housing. These anemic expenditures translated to only 36 new homes having been constructed. By 2013, only 41% of all of the homes damaged or destroyed by Hurricane Ike had been rebuilt or rehabilitated according to the State General Land Office (Wilder, 2013). The U.S. Department of Housing and Urban Development's Community Development Block Grant Program (CDBG) has been used by Congress to send disaster-recovery funds to the states, which is then earmarked to be used toward block grants to fund low-income housing, economic development, and anti-poverty projects. Much of what makes the process long and drawn out is that the states have full discretion in administering the funds to communities. In the cases of communities facing disaster recovery, such procedures cannot be changed (Wilder, 2013). Thus, if the state is slow or hesitant to issue CDBG funding to communities for recovery efforts following a natural disaster, those communities are at the mercy of the bureaucratic processes of state government.

Still, it appears that politics in Galveston added an additional obstacle to the slow pace of recovery on the island. Despite the fact that funding was available for the rehabilitation of low-income housing on the island, city leaders and the general public were vehemently opposed to it. By 2013, despite legally binding agreements between the City of Galveston and the U.S. Government through TDHCA, the City of Galveston had yet to repair any of the city's public housing units. Such failures led the Texas General Land Office to threaten to cease funding Galveston in any capacity—which would have resulted in the loss of billions of dollars in funding. Hurricane Ike destroyed four of the island's six public housing developments, and community advocates indicate that much of the tensions circulating around the redevelopment of public housing on the island centered on racial and social biases of excluding poor individuals from the rebuilding process.

Such notions extend as far back as 2008 when Galveston's mayor single-handedly created a disaster-recovery committee full of many of the city's businessman—thereby excluding many of the city's African American and Hispanic residents, which comprised roughly 50% of the local population (Wilder, 2008). It is also important to note that the many of the city's housing projects were located on the island's north side—north of Broadway Street—on the Galveston Bay side of the island. Historically, this area was where many of the city's African Americans lived when city leaders made a push to uproot African American residents from historically integrated neighborhoods and concentrate them here. These communities were redlined as black neighborhoods, and they largely became sites of urban disinvestment, which led to heavy concentrations of poverty.

Not having the protection of the seawall, the North Side of the city experienced some of the worst damage during Hurricane Ike, as water surged from Galveston Bay inundating homes and businesses—many of which were older and not originally constructed under building codes. Based on early FEMA assessments, the neighborhoods north of Broadway had mostly been determined to have sustainable ample structural damage and could possibly have been uninhabitable, whereas many of the properties south of Broadway—which stood on higher ground behind the 17-foot seawall—faced minimal destruction. Clearly, such disparities are rooted in a history of racial/ethnic and economic segregation, putting specific communities at a disadvantage in terms of their risk and susceptibility to being able to recover from shocks. Thus, claims of biases from community advocates were not unfounded (Wilder, 2008).

As mentioned previously, in May 2010, the U.S. Department of Housing and Urban Development approved an agreement that mandates that the State of Texas rebuild all public housing lost on Galveston Island due to Hurricane Ike. From this agreement, the State of Texas

was responsible for replacing all of the 569 units lost to Hurricane Ike in ways that "would affirmatively further fair housing," including finding ways to overcome local opposition to ensure that public housing was rebuilt throughout the city (Walters, 2018). Community advocates note that the opposition to rebuilding public housing on the island was largely race- and class-based (Wilder, 2012). When asked about the racial strife and threats of federal lawsuits that occurred in the years following Hurricane Ike, John Hennenberger of the Texas Low-Income Housing Information Service noted that Galveston served as the perfect example of how local opposition and delaying tactics could thwart civil rights laws aimed at stopping housing discrimination (Walters, 2018).

> "There is nothing more cruel than saying that people who lost their homes to the hurricane should go away and not come back. That's the clear message that's being conveyed by a number of [···] people in Galveston."
>
> John Henneberger, Texas Low Income Housing Information Service
> Source: The Texas Observer, 2012

Similar to what was done in New Orleans following Hurricane Katrina, city officials—including then-mayor Joe Jaworski and the leader of the Galveston Housing Authority—instead proposed the rebuilding of mixed-income developments, which were to be spread throughout the city. In November of 2012, however, the Galveston City Council rejected the plan, and several members of the council called on the State of Texas to deny federal tax credits for the construction of low-income housing (Wilder, 2012). The position of the City Council representatives largely represented the biases held by many Galveston residents that public housing residents were a drain on the economy. That same year, both mayoral candidates who

ran in opposition to Mayor Joe Jaworski ran on platforms to eliminate public housing in Galveston.

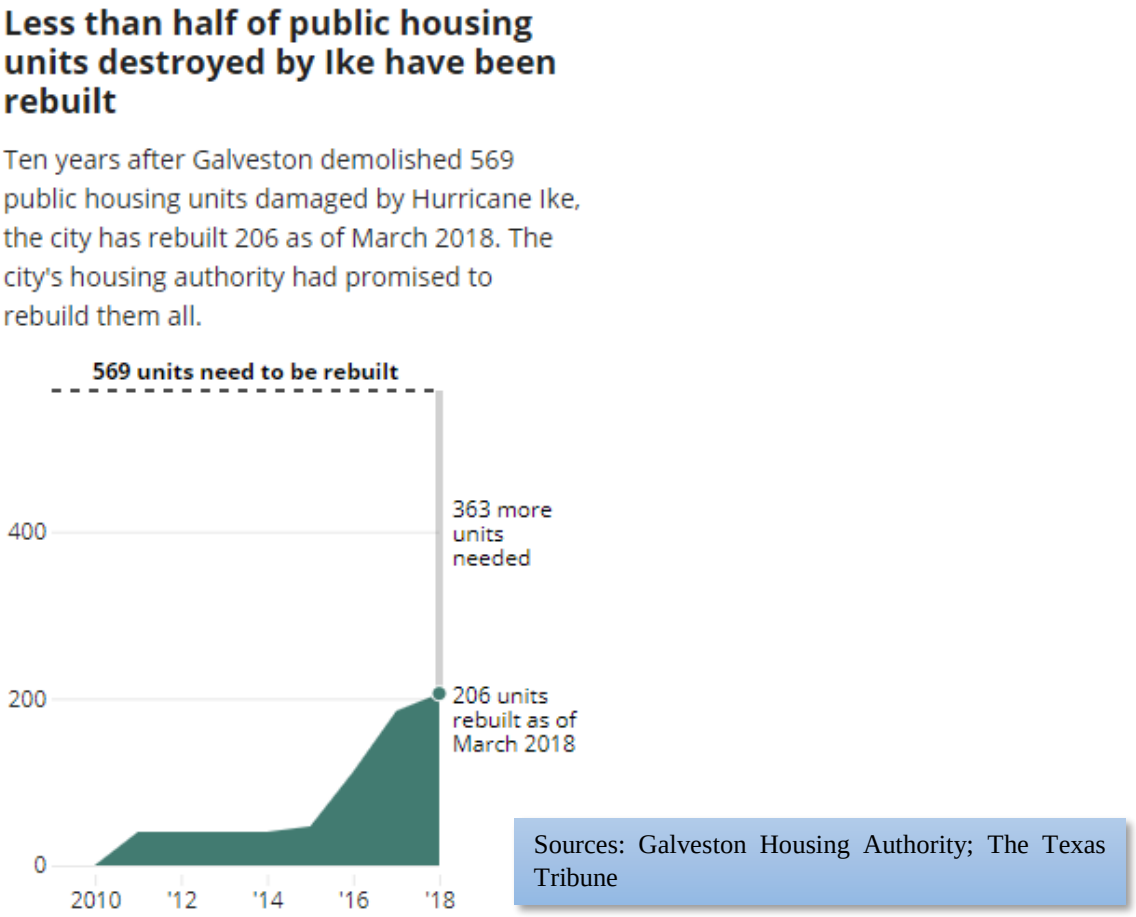
> "It sends a message to Washington; it sends a message to Austin; it sends a message right here on the streets of Galveston that this council or certain members of this council simply don't want lower-income families and individuals living in this community."
>
> Betty Massey, Galveston Housing Authority
> Source: The Texas Observer, 2012

Efforts of housing advocates did not come to fruition until 2014, when the Cedars at Carver Park and Villas on the Strand complexes reached completion after redevelopment as mixed-income housing. Both sites were developed by the Texas General Land Office, costing approximately $21 million and including 63 subsidized units and 59 market-rate units at the Cedars and 78 market-rate units at Villas on the Strand. While the combined development total of subsidized units fall well below the 569 units that the Galveston Housing Authority promised to rebuild following Hurricane Ike, the General Land Office will remain responsible for constructing the rest of the units throughout the island—which will be difficult considering the lack of available land on which the organization could construct affordable housing that meets existing needs and is safe from hazards (Walters, 2018).

As of late, the General Land Office has set aside $66 million through federal disaster grant money received for the remaining units, but the properties will be owned and maintained by the Galveston Housing Authority. Currently, the earmarked money has to be spent before the end of 2019, or the ability to restore public housing in Galveston could be lost. Currently, the city has presented a list of available properties for the construction of the remaining units to the

General Land Office, with 100 units being located north of Broadway, 100 units south of Broadway, and 87 units in locations that have yet to be decided. The problem with this proposal however lies in the fact that the units slated for construction north of Broadway lie in an area that still remains increasingly vulnerable to storm tides from hurricanes and other forms of flooding, in addition to already having a concentration of low-income residents (Powell, 2018).

Other proposals include locating some of the units across West Bay on the "mainland" in Texas City. Coincidentally, many residents who could not afford to live in Galveston due to lack of affordability have since relocated here and to other parts of Galveston County and the larger metropolitan area. However, there are existing federal requirements that any public housing built with the funds outside of Galveston (off the island) could violate state and federal mandates to rebuild Galveston public housing on a one-for-one basis, in addition to failing to promote fair housing requirements of constructing such housing in high-opportunity neighborhoods (Powell, 2018).



The effects of the long struggle did not come without consequences. The Federal Reserve Bank of Dallas, a long-time funder of affordable housing projects throughout the State of Texas that studies community development and monetary policy, released a report in March 2018 that revealed that Galveston's failure to rebuild public housing following Hurricane Ike had detrimental effects on the local economy, including a city a that is "less economically diverse" today than it was before the storm and more "likely to face serious workforce challenges in future years as the region sees continued economic growth" (Walters, 2018). Data also reveals that the city's failure to act resulted in the decrease of both non-White residents, as well as low-income residents—many of whom bore the brunt of displacement following the storm (Walters, 2018). The fact that the city's comprehensive plan promoted the restoration acknowledged the

projected decreases in the city's workforce indicates an awareness of the lack of affordability. Between 2009 and 2016, the median income on the island rose by more than $6,000, also indicating an increase in the lack of affordability on the island (Walters, 2018).

The years of debate and controversy surrounding housing affordability in Galveston indicate that the planning process for sustainable housing that is resilient and accessible to people of all income backgrounds is largely a political one. Unlike what is currently occurring in New Orleans with the city's active pursuit of sustainable, affordable housing for all residents as a component of resilience planning, Galveston—despite what the city aspires to in its Comprehensive Plan—has not been nearly as successful. Furthermore, local politicians in Galveston have largely been the force of opposition to the development of affordable housing, especially public housing, on the island. In comparing Galveston and New Orleans, it appears that New Orleans is far more progressive in terms of its strides toward making the city a livable place for all of its residents.

Conclusion

Rapid population growth and environmental changes point to the need for cities to reinvent themselves as places that can adapt—meaning that they can effectively plan for shocks and sudden changes beforehand instead of having to adapt to them. Planning such complex places requires the ability to view the city holistically, analyzing the ways in which the environment affects and is affected by development, how development strategies must be adapted to comply with foreseeable changes to the natural environment, and understanding how to develop and grow with what is naturally available to a city or region in a way that spurs economic development and growth while also protecting the surrounding area. This is sustainability. Achieving sustainability through planning is essentially what makes cities resilient.

Thus, resilience and sustainability are essential components of one another. Implementing sustainable development and planning through informed policy is the most viable way to develop resilient cities. What the research and data gathered through this report have sought to reveal is that cities must view all aspects of their planning design as interconnected components in order to successfully achieve true resilience. A city working toward making itself more resilient should set sustainability goals and actively work toward achieving those goals through continued research, related policy, and practice. The same can be said for cities aiming to build sustainable housing and economies in efforts to make themselves more resilient.

Having analyzed the planning and research established in the Resilience Strategy for the City of New Orleans, what was evident is that the city understood that its capacity to sustainably plan for adaptations to be made was largely dependent on the ability of city officials to work with stakeholders from all backgrounds, including non-governmental research organizations, non-profit advocacy groups that worked on behalf of citizens, businesses, and government

officials at higher levels in order to evaluate what was best for the region as a whole. The city was able to successfully acknowledge what went wrong in the past from angles pertaining to poor environmental planning and practices in housing development, while attempting to devise ways to correct those past errors as forms of mitigation toward moving toward a more sustainable future.

To the credit of New Orleans and the surrounding region, the impacts felt locally from recent natural disasters—such as Hurricane Katrina in 2005—have been a driving force in the motivation of regional actors to sufficiently analyze such changes. On the contrary, the Houston-Sugar Land-The Woodlands Metropolitan Area has seen two major environmental shocks in the same period of time—most notably, Hurricane Ike in 2008 and Hurricane Harvey in 2017, the latter of which sparked discussions on how to best implement better environmental practices among other measures of sustainability. In contrast to New Orleans however, Galveston's latest comprehensive plan, which was completed in 2011, embraces scientific research to some extent on the importance of sustainable development and changes that need to be made, but the plan only makes recommendations on what the city could do in the future, leaving outcomes largely up to the existing political processes.

Galveston's Comprehensive Plan claims to have incorporated input from Galveston locals from various backgrounds and walks of life in the development of the comprehensive plan. Nevertheless, literature detailing the fight for the restoration of low-income housing on the island, in addition to the revelation that many low-income residents no longer reside on the island, raises questions about the veracity of such claims. Furthermore, the plan's subtle bias against low-income residents and acknowledgement of the decline of moderate and middle-income residents lead one to speculate that the city's most vulnerable might not have held as

much of a voice in the planning process as was claimed. Furthermore, Galveston should update its plan to be a more integrative strategy that embodies all aspects of resilience. For example, while the plan delved into a variety of planning issues when making recommendations, there were several instances when other plans, such as the city's Hazard Mitigation Plan, were referenced. The strategies outlined in the city's Hazard Mitigation Plan should undoubtedly be outlined in depth in the Comprehensive Plan.

Finally, what is key to the process of planning for resilience is the ability of cities to adapt existing planning strategies to unforeseen changes. Additional research has indicated that resilient cities are those that adapt and change to become prepared for future shocks as opposed to simply responding to a shock post-occurrence. When comparing efforts undertaken in Galveston and in the larger Houston-Sugar Land-The Woodlands Metropolitan Area with strategies employed in New Orleans and South Louisiana, it is evident that the Upper Texas Coast has ample work to do toward implementing sustainable planning for a more resilient city and region. Nevertheless, the work that Galveston has done toward incorporating sustainable planning elements in its plan could comprise an important step toward making Galveston a resilient city.

Further Research

In this report, I found that sustainable planning for resilience has been implemented on the United States Gulf Coast, particularly in New Orleans and South Louisiana. In fact, having been modeled after strategies employed in the Netherlands, the strategies employed on the Louisiana Gulf Coast should serve as a model toward resilience planning for other cities in the region. Planning for resilience and sustainability on the Upper Texas Coast, especially in Galveston, has not made strides as significant as those in Louisiana. Nevertheless, there are

many opportunities for future research to further explore other components of resilience, such as those that focus on the human aspect of planning—including crime, health, and education—and how they are linked with environmental, housing, and economic stability.

References

Adelson, J. (2019, January 19). New Orleans City Council takes first step toward imposing stricter short-term rental rules. *The New Orleans Advocate*. Retrieved from https://www.theadvocate.com/new_orleans/news/article_28dfc12a-1520-11e9-bdfe-27181efdebc4.html

American Rivers Foundation. (2017). What Are Prairie Potholes. Retrieved from https://www.americanrivers.org/rivers/discover-your-river/prairie-potholes/

Asakura Robinson Company, Greater New Orleans Housing Alliance, Alliance for Affordable Energy, & GCE Services. (2018). *New Orleans Rental Market Study* (Rep.). New Orleans, Louisiana.

Bates, L. (2006). Post-Katrina Housing: Problems, Policies, and Prospects for African-Americans in New Orleans. *The Black Scholar, 36*(4), 13-31. Retrieved from http://www.jstor.org/stable/41069219

Best, E.P.H., Verhoeven, J.T.A. & Wolff, W.J. Hydrobiologia (1993) 265: 305. https://doi.org/10.1007/BF00007274

Brody, S. D., Davis, S. E., Highfield, W. E., & Bernhardt, S. P. (2008). A spatial-temporal analysis of section 404 wetland permitting in Texas and Florida: Thirteen years of impact along the coast. *Wetlands, 28*(1), 107-116. doi:10.1672/07-90.1.

Brooks, D. (2005, September 08). Katrina's Silver Lining. Retrieved from https://www.nytimes.com/2005/09/08/opinion/katrinas-silver-lining.html

Campbell, Scott. (2016). The Planner's Triangle Revisited: Sustainability and the Evolution of a Planning Ideal That Can't Stand Still. Journal of the American Planning Association. 82. 388-397. 10.1080/01944363.2016.1214080.

City of Galveston Office of Economic Development. (2018). Economic Development. Retrieved from https://www.galvestontx.gov/541/Economic-Development.

City of New Orleans. (2015). Resilient New Orleans: Strategic Actions to Shape our Future City. Retrieved from http://resilientnola.org/wp-content/uploads/2015/08/Resilient_New_Orleans_Strategy.pdf

Cooley, J. (2015, April 10). Coastal Prairie and Pothole Wetlands. Retrieved from https://valuewetlands.tamu.edu/2015/04/10/prairie-pothole-wetlands-of-the-upper-texas-coast-plain/

Cutillon, T.J., M.A. Warren, T.R. Goodspeed, D.G. Remer, C. M. Blackwell, and J.J. McDonough. (1990). 50 Years of Population Change along the Nation's Coasts: 1960-2010, A Special Earth Week Report. Rockville, MD: DOC, NOAA (Coastal Trends Series No. 2).

Daly, H. E., Cobb, J. B., & Cobb, C. W. (1989). *For the common good: Redirecting the economy toward community, the environment, and a sustainable future*. Boston: Beacon Press.

Dolfman, M. L., Fortier, S., & Bergman, B. (n.d.). The Effects of Hurricane Katrina on the New Orleans Economy. *Monthly Labor Review*. Retrieved June, 2007, from https://www.bls.gov/opub/mlr/2007/06/art1full.pdf.

Environmental Protection Agency. (2017, December 05). Section 404 Permit Program. Retrieved from https://www.epa.gov/cwa-404/section-404-permit-program.

Foundation for Louisiana. (2018). LA SAFE: Summary of Strategy Development and Project Selection. Retrieved from https://s3.amazonaws.com/lasafe/2018/N-04/2018-Summary-Strategy-Development-Project-Selection.pdf.

Fukuda, Chisako. (2014). Detroit's Future City Framework Offers Lessons on Resilience. 1 – 3.

Galveston Housing Authority. (2018). Overview-History. Retrieved from http://www.ghatx.org/dev_reconstruction.html

Goetz, E.G. (2013). *New Deal Ruins: Race, Economic Justice, and Public Housing Policy.* Ithaca: Cornell University Press.

Gotham, K.F. & Greenberg, M. (2014). *Crisis Cities: Disaster and Redevelopment in New York and New Orleans.* New York: Oxford University Press.

Greater New Orleans Housing Alliance. (2018). Rebuilding NOLA. Retrieved from http://www.gnoha.org/main/put_housing_first

Hardy, S. (2018, September 11). South Louisiana parishes score $41 million for flood-resiliency projects. Retrieved from https://www.theadvocate.com/baton_rouge/news/environment/article_acf32cfc-b60e-11e8-8c17-1392ef57aa27.html

Harpaz, B. J. (2015, August 13). 10 years after Katrina, New Orleans' tourism industry a textbook success story of rebirth. Retrieved from https://globalnews.ca/news/2163713/10-years-after-katrina-new-orleans-tourism-industry-a-textbook-success-story-of-rebirth/

Hight, C., Robinson, M., Anderson, J., Robinson, D., Rice University School of Architecture, & Shell Center for Sustainability. (2010). *Atlas of sustainable strategies for Galveston Island*. Houston, TX: Rice University.

Huang, Y. et. al. (2010). Marshland conversion to cropland in northeast China from 1950 to 2000 reduced the greenhouse effect. *Global Change Biology.* 16, 680-695 (2010).

J. Bartik, Timothy. (1990). The Market Failure Approach to Regional Economic Development Policy. Economic Development Quarterly - ECON DEV Q. 4. 361-370. 10.1177/089124249000400406.

Jacob, J. (2015, December 18). The fight for Texas' prairie wetlands. Retrieved from https://www.houstonchronicle.com/local/gray-matters/article/wetlands-6704939.php

Johnson, C. (2011). Introduction: The Neoliberal Deluge. In Johnson, C. (Ed.), *The Neoliberal Deluge: Hurricane Katrina, Late Capitalism, and the Remaking of New Orleans,* (xvii-l). Minneapolis: University of Minnesota Press.

Jones Carter. (2018, August 06). USACE Funds May Go To The Ike Dike - But What Is It? | Jones|Carter Engineering Blog. Retrieved from https://www.jonescarter.com/blog/hydrology-and-hydraulics/usace-funds-may-go-to-the-ike-dike-but-what-is-it

Kakissis, J. (2017, November 25). Protecting the Netherlands' Vulnerable Coasts with A 'Sand Motor'. Retrieved from https://www.npr.org/sections/parallels/2017/11/25/564098130/protecting-the-netherlands-vulnerable-coasts-with-a-sand-motor

Katz, C. (2013, February 21). To Control Floods, The Dutch Turn to Nature for Inspiration. Retrieved from https://e360.yale.edu/features/to_control_floods_the_dutch_turn_to_nature_for_inspiration

Keddy, P. (2016). *Wetland Ecology: Principles and Conservation*. Cambridge: Cambridge University Press.

Kirwan, M. L., & Megonigal, J. P. (December 2013). Tidal wetland stability in the face of human impacts and sea-level rise. *Nature, 504* (7478), 53-60. doi:10.1038/nature12856

Kolker, A. S. (2018, July 10). Plaquemines Gazette Letter to the Editor: River Diversions. Retrieved from http://mississippiriverdelta.org/plaquemines-gazette-letter-to-the-editor-river-diversions/?fbclid=IwAR3jqgOgdqo5_9QqdtA3w1yo-aZLEEjyze3u1h-OSgLju3jPR2pf8pjxAdU

Lane, Robert & Day, John & N. Day, Jason. (2006). Wetland surface elevation, vertical accretion, and subsidence at three Louisiana Estuaries receiving diverted Mississippi River water. Wetlands. 26. 1130-1142. 10.1672/0277-5212(2006)26[1130: WSEVAA]2.0.CO;2.

Litten, K. (2019, January 25). New Orleans steps carefully toward affordable housing requirements. Retrieved from https://www.nola.com/politics/2019/01/on-affordable-housing-new-orleans-city-council-takes-early-steps-knowing-more-work-lies-ahead.html

Masson, T. (2016, November 03). Cutting holes in levees has created more land than expected south of Venice. Retrieved from https://www.nola.com/outdoors/2016/11/cutting_holes_in_levees_has_cr.html

Mcclendon, R. (2015, July 30). Where will working poor live in future New Orleans, if gentrification continues? Retrieved from https://www.nola.com/futureofneworleans/2015/07/where_will_the_working_poor_li.html

Mitsch, W. J., & Gosselink, J. G. (2015). *Wetlands*. Hoboken: John Wiley & Sons.

Pendleton, L., et. al. (2012). Estimating global "blue carbon" emissions from conversion and degradation of vegetated coastal ecosystems. *PLoS ONE* 7, e43542 (2012).

Perry, J. (2012, October 14). "The Road Home" Is a Road to Nowhere for Black New Orleanians. Retrieved from http://www.plannersnetwork.org/2010/10/the-road-home-is-a-road-to-nowhere-for-black-new-orleanians/

Powell, N. (2018, November 13). Ike Dike concept raises more questions than it answers for environmentalists and Rice University. Retrieved from https://www.houstonchronicle.com/news/houston-texas/houston/article/Ike-Dike-concept-raises-more-questions-than-it-13378121.php

Powell, N. (2018, October 21). Advocates: Galveston public housing proposals are insufficient. Retrieved from https://www.houstonchronicle.com/news/houston-texas/houston/article/Advocates-Galveston-public-housing-proposals-are-13325162.php

Powell, N. (2018, October 30). Army Corps gives nod to $31B 'Ike Dike' plan to protect Texas coast. Retrieved from https://www.houstonchronicle.com/news/houston-texas/houston/article/Army-Corps-gives-nod-to-31B-Ike-Dike-plan-13340756.php

Random House Publishing, Inc. (1998). *Random House Dictionary, Sustainability"*. New York, NY: Random House Publishing. https://www.dictionary.com/browse/sustainability

Rees, W. E. (1990). Sustainable development as capitalism with a green face: A review article [book review of Blueprint for a Green Economy: A Report for the UK Department of the Environment by David Pearce, Anil Markandya and Edward B. Barbier]. The Town Planning Review, 61(1), 91. doi:10.3828/tpr.61.1.p3126710237k8k70.

Rice, H. (2014, May 15). What Will Protect Us from the Next Storm Surge? *Houston Chronicle*[Houston]. Retrieved from http://www.chron.com/news/article/What-will-protect-us-from-the-next-surge-4560827.php

Rolf Pendall, Kathryn A. Foster, and Margaret Cowell. (2009). "Resilience and Regions: Building Understanding of the Metaphor," *Cambridge Journal of Regions, Economy, and Society*, 3:1, 10-11.

Schuerch, M., Spencer, T., Temmerman, S., Kirwan, M. L., Wolff, C., Lincke, D., . . . Brown, S. (2018). Future response of global coastal wetlands to sea-level rise. *Nature, 561*(7722), 231-234. doi:10.1038/s41586-018-0476-5

Seicshnaydre, S., Collins, R. A., Hill, C., & Ciardullo, M. (2018, April 5). Rigging the Real Estate Market: Segregation, Inequality, and Disaster Risk. Retrieved from

https://www.datacenterresearch.org/reports_analysis/rigging-the-real-estate-market-segregation-inequality-and-disaster-risk/

Sifneos, J.C., M.E. Kentula, and P. Price. 1992. Impacts of Section 404 permits requiring compensatory migration of freshwater wetlands in Texas and Arkansas. The Texas Journal of Science 44:475-85.

Sinel, M.J.A. (2016). *Affordable Housing Disaster Resilience in the Neoliberal Era: The LIHTC in Galveston, TX, through Hurricane Ike* (Unpublished master's thesis). The University of Texas at Austin.

Singer, P. (2015, July 28). Louisiana still finding Katrina damage. Retrieved from https://www.usatoday.com/story/news/politics/2015/07/28/louisiana-still-finding-katrina-damage/30459513/

Swanstrom, Todd. (2008). "Regional Resilience: A Critical Examination of the Ecological Framework," 4.

Texas A&M Agrilife Extension. (n.d.). Texas Coastal Wetlands: Riverine Forested Wetlands. Retrieved from https://texaswetlands.org/wetland-types/riverine-forested-wetlands/

Texas Coastal Watershed Program. (2015). https://agrilifecdn.tamu.edu/urbannature/files/2015/12/Connectivity-Fact-Sheet-7-11-ESP391-2.pdf

Tresaugue, M. (2011, August 02). 'Prairie potholes' fill water need, A&M researchers say. Retrieved from https://www.chron.com/news/houston-texas/article/Prairie-potholes-fill-water-need-A-M-1690971.php

U.S. Census Bureau. (2007). American Community Survey 3-year Estimates. Retrieved from census.gov.

U.S. Census Bureau. (2010) Census 2010. Retrieved from https://www.census.gov/quickfacts/fact/table/galvestoncitytexas/PST045218

UN Habitat for a Better Future. (2018). What is urban resilience? Retrieved from http://urbanresiliencehub.org/

US Department of Commerce, & National Oceanic and Atmospheric Administration. (2009, August 27). What is resilience? Retrieved from https://oceanservice.noaa.gov/facts/resilience.html

Walters, E. (2018, April 16). "It's our form of apartheid": How Galveston stalled public housing reconstruction in the 10 years after Ike. Retrieved from https://www.texastribune.org/2018/04/16/galveston-public-affordable-housing-hurricane-ike/

Way, H., Mueller, E., & Wegmann, J. (2018). Uprooted: Residential Displacement in Austin's Gentrifying Neighborhoods, and What Can Be Done About It. Retrieved from https://sites.utexas.edu/gentrificationproject/

Wilcox, Bradford & D. Dean, Dex & Jacob, John & Sipocz, Andrew. (2011). Evidence of Surface Connectivity for Texas Gulf Coast Depressional Wetlands. Wetlands. 31. 451-458. 10.1007/s13157-011-0163-x.

Wilder, F. (2008, December 12). The Castaways:CanCastaways: Can Galveston's black community survive the island's comeback? *The Texas Observer*. Retrieved from https://www.texasobserver.org/2918-the-castaways-can-galvestons-black-community-survive-the-islands-comeback/

Wilder, F. (2012, November 02). Galveston's Nasty Public Housing Fight. Retrieved from https://www.texasobserver.org/galvestons-nasty-public-housing-fight/

Wilder, F. (2013, September 20). Five Years On, Hurricane Ike Recovery Still Painfully Slow. Retrieved from https://www.texasobserver.org/five-years-hurricane-ike-recovery-effort-drags/

Wilder, F. (2017, August 25). Aftershock. Retrieved from https://www.texasobserver.org/aftershock

Williams, J. (2016, February 14). HANO opens waiting lists for housing units in New Florida development, other sites. Retrieved from https://www.theadvocate.com/new_orleans/news/politics/article_7682ab85-049f-5826-9143-f356500efaff.html

Williams, J. (2018, December 24). Developers chosen to build affordable single-family homes in Lower 9th Ward. Retrieved from https://www.theadvocate.com/new_orleans/news/article_1eab30e6-0796-11e9-9ccb-bbe84f64fb21.html

Williams, J. (2019, February 10). City Council urges Legislature to consider more property tax breaks for New Orleans residents. Retrieved from https://www.theadvocate.com/new_orleans/news/article_b16d68e2-2b2a-11e9-b041-bb2587bad00f.html

Williams, J. (2019, January 27). HANO considering new proposals for affordable housing in Algiers, Upper 9th Ward, more. Retrieved from https://www.theadvocate.com/new_orleans/news/article_88d50d4c-1f61-11e9-900e-47be69feba95.html

Wolff, W. (1992). The End of a Tradition: 1000 Years of Embankment and Reclamation of Wetlands in the Netherlands. *Ambio, 21*(4), 287-291. Retrieved from http://www.jstor.org/stable/4313944

Woodward, A. (2019, January 21). How 'redlining' shaped New Orleans neighborhoods - is it too late to be fixed? Retrieved from https://www.theadvocate.com/gambit/new_orleans/news/article_e0b3b32e-19e4-11e9-8850-ebd36b3c414d.html